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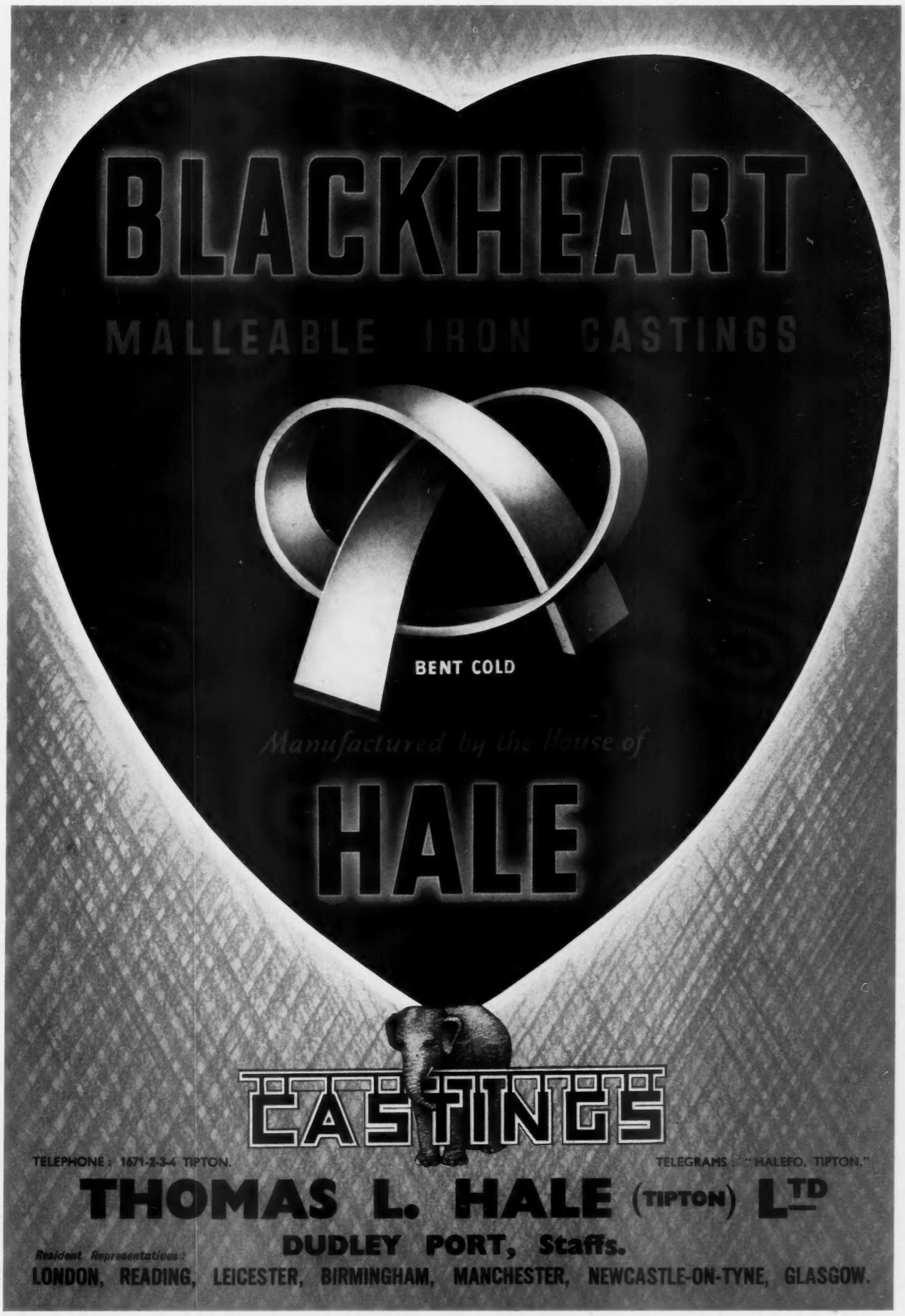

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Top:
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Below:
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A Seven-Day Journal

The Channel Tunnel.

AT the annual general meeting of the Channel Tunnel Company, Ltd., which took place in London last week, Baron Emile B. D'Erlanger, the chairman, said that the company was marking time, whilst paying its way. He further stated that he had been greatly exercised in his mind as to the course the board should pursue in the face of the great changes that had come over the world and which had a direct bearing upon the scheme. The nationalistic spirit was not to be confounded with the laudable patriotic feelings which should animate citizens of any and all countries; that nationalistic spirit had permeated all communities of the world and reduced to its minimum the human as well as the commercial intercourse between them. That state of things had evoked a general feeling of distrust between all countries, and was consequently unfavourable, at least in the minds of many people, to a revival of the company's project. For all that, he remained convinced that the day would come when a tunnel would be built to connect this country with the Continent, to facilitate the transport of passengers by train, to make it possible to accomplish the journey by motor car, and as one of the best means of military defence in case of war, or as a means of security to prevent it. He had consulted the Southern Railway Company, the largest holder of the Channel Tunnel Company's shares, and other shareholders, and the wish had been expressed that the company should continue its life struggle.

Oil in Great Britain.

THE new regulations governing the search for petroleum in Great Britain have now been laid on the tables of both Houses of Parliament, and they will become effective, if not disapproved, within twenty-eight days. Applications for licences may be made as from June 17th next. The new regulations, which have been drawn up under the Petroleum Production Act of 1934, provide for two kinds of licences, namely, prospecting and mining. The prospecting licence has a period of three years, which may be extended year by year to a maximum of five years, while the mining licence is for fifty years, which may be extended to seventy-five years. The licences cover reasonably large areas and the regulations have been specially designed to ensure that the work shall be carried out by concerns which are properly equipped to undertake the task of prospecting in accordance with the best oilfield practice. The petroleum regulations permit applications for licences . from foreigners and from companies incorporated outside Great Britain, the only substantial condition being that an operating company must be formed and registered in this country. The regulations provide that the rate of royalty on crude oil shall never be less than 3s. per ton, nor more than 6s. per ton. Royalty on casing-head petroleum spirit recovered is not to be less than ⅛d. per gallon, and must not exceed 2d. per gallon.

New Reservoirs for London.

ON Thursday, May 16th, the Select Committee of the House of Commons on Unopposed Bills had under consideration the Metropolitan Water Board Bill, under which authority is sought to construct various new works, including a reservoir covering 417 acres in the Staines area and another about 374 acres in extent in the Walton and Weybridge area. The latter reservoir would involve the submerging of Mr. F. W. Secrett's Holly Lodge Farm. Mr. C. E. Browne, of Dyson Bell and Co., parliamentary agents, said that the Ministry of Health in a report on the Bill expressed the view that further storage reservoirs were essential, and that the proposed site at Walton was the only one that was feasible. The Board had come to an agreement with Mr. Secrett, the lessee of the farm, that he should exercise his option to purchase the farm, and the Board would then buy the freehold from him at an agreed figure. The arrangement was that Mr. Secrett should remain in possession for at least two years. That would give him time, if he thought fit to do so, to change to some other farm, and the Board hoped that the necessity of taking this farm from him would not mean any very serious delay in the development of his agricultural research. The Committee found the preamble of the Bill proved, and it was ordered to be reported for third reading.

A Vickers-Armstrongs Appointment.

ON Friday, May 17th, the announcement was made that Engineer Rear-Admiral Robert Beeman had been appointed a special director of Vickers-Armstrongs, Ltd., and engineering manager of the firm's Barrow works. Since 1932, Rear-Admiral Beeman has been Deputy Engineer-in-Chief to the Admiralty, and he relinquished that position on May 14th. He joined the Royal Navy in 1901 and in the pre-war years saw considerable service both at home and abroad. He was present at the Battle of Jutland in the destroyer H.M.S. "Nerissa," and his services on that occasion were mentioned in despatches. Later in the war he was appointed to the Department of the Engineer-in-Chief, and in 1932 became Deputy Engineer-in-Chief. Rear-Admiral Beeman has been a naval *aide-de-camp* to His Majesty the King, and for some time he was instructor at the Royal Naval College, Greenwich. He is a member of the Council of the Institution of Naval Architects. There is no doubt that in his new appointment he will find new scope for his wide knowledge of marine engineering in all its branches. At the Admiralty he is succeeded by Engineer Rear-Admiral George Preece, who was Assistant Engineer-in-Chief at the Admiralty for six years up to December last, and served under Admiral Beatty in H.M.S. "Lion" during the war as engineer lieutenant-commander, and was mentioned in despatches for his services in the action off the Dogger Bank. After he was relieved in 1916 he served at the Admiralty and later on the staff of Keyham College. From 1923 to 1927 he was Professor of Marine Engineering at the Royal Naval College, Greenwich, and in 1927–28 was Fleet Engineer Officer on board H.M.S. "Nelson."

New Naval Ships.

ON Saturday, May 18th, the destroyer H.M.S. "Fury," the sixth of the eight destroyers of the "Fearless" class, completed her acceptance trials. She was commissioned at Portsmouth on Monday last. She was built and engined by J. Samuel White and Co., Ltd., at Cowes. Like her predecessors she is a ship of 1375 tons displacement, and is armed with four 4·7in. guns, seven smaller guns, and eight torpedo tubes. Her single-reduction geared turbine machinery, taking steam from water-tube boilers, has a trial output of 36,000 s.h.p., corresponding to a speed of 35½ knots. During Saturday's trials very satisfactory results were obtained and the contract speed was exceeded. It may be here recalled that the published trial speeds of British destroyers are the mean speeds of several runs with the vessel complete and in service condition, and without any overload on the machinery. The speeds attained can therefore be reproduced afterwards on actual service and over extended periods, and, unlike some foreign trial results, they represent accurately the seagoing performances of the vessels concerned. Another naval ship, recently completed for the Royal Indian Navy, is the new sloop "Indus," constructed by R. and W. Hawthorn, Leslie and Co., Ltd. She has a tonnage of 1230, and her propelling machinery consists of two independent sets of single-reduction geared turbines of the latest Parsons type, driving twin screws at about 275 r.p.m. An astern turbine is incorporated in each low-pressure turbine, and cruising stages are provided in the high-pressure turbines to ensure a high degree of efficiency over a wide range of cruising power. The machinery is designed to develop a total of 2000 s.h.p. and steam at 250 lb. pressure is supplied by two oil-fired water-tube boilers.

Advice on Blind Flying.

THE Air Ministry has issued an advisory notice calling attention to the dangers of cloud flying and the radio control of aircraft flying blind. The notice applies to the whole of Great Britain, with the exception of the London–Continental airways area, for which traffic rules have already been framed. The notice states that all cloud flying by flying schools and clubs for purposes of practice should be confined to certain marked areas, while all aircraft engaged in cross-country flights should avoid the clouds as much as possible. Any machine which does not carry a radio transmitter, if obliged to fly in cloud, should not go higher than 2000ft. above ground level. Such machines, however, should not fly in cloud unless absolutely compelled to do so, as they have no means of warning other machines of their presence. Machines with complete radio equipment, when entering a cloud, should notify the nearest radio station of their position and speed, so that other aircraft in the vicinity can be warned. Similarly they should notify the station when they leave the cloud bank. When an aerodrome is shrouded in mist or fog all pilots should circle three miles outside it and notify the aerodrome radio station of their position. The traffic control officer will then direct them to the landing ground in turn. He may also find it necessary to direct the outward bound aircraft by means of flares or wireless. The notice concludes with a grave warning that a pilot disregarding this advice may endanger not only his own machine, but those of other pilots.

The Russian Air Disaster.

IT is with deep regret that we have to record the complete loss of the "Maxim Gorky," the large eight-engined Russian aeroplane, which crashed during a demonstration flight at Moscow about midday on Saturday last, killing the entire crew and passengers, numbering forty-eight persons. Those on board included a crew of eleven, and engineers and workers from the Central Aerodynamic Institute, and members of the Working Men's Institute, with several members of their families. While at a height of about 2250ft. a small aeroplane looping the loop touched the wing of the large monoplane, which thereupon broke in mid-air and fell near the village of Sokol, near Moscow. The "Maxim Gorky," or A.N.T. 15, was completed last year, and was intended for propaganda work. It was an all-metal monoplane with a total wing span of 210ft. and a wing thickness of about 6ft. It carried eight 850 h.p. water-cooled engines, two arranged in a nacelle above the fuselage, and the remaining six in line along the front of the wings. The maximum speed was stated to be about 149 miles per hour, with a cruising speed of about 137 miles per hour, and a fuel range of approximately 1240 miles. In order to fulfil its mission as a propaganda machine, it was fitted with editorial, printing and photographic facilities, and broadcasting equipment which would allow lectures, news, and music to be broadcast from a height of 3000ft. On Monday last the Soviet Government announced that three new aeroplanes of the same type and size as the "Maxim Gorky" will be built. They will bear the names of "Vladimir Lenin," "Joseph Stalin," and "Maxim Gorky."

Shorter Hours in Industry.

IN the course of his Presidential Address at the fourth British Glass Convention, which was held at Folkestone on Thursday, May 16th, Mr. G. L. Pilkington, of St. Helens, Lancashire, referred to the mechanisation of industry and its effect on employment and the quality and design of products. Mechanical processes, he said, were bound to increase unemployment unless sufficient machines were installed to absorb all those who were previously engaged in the hand-operated processes, and that was obviously an impossibility unless consumption increased. Accordingly, he suggested a palliative, and that was the shortening of working hours. His firm introduced a proposal to the St. Helens Plate and Sheet Glass Industrial Council, which after consideration announced its approval of the scheme. It was put into operation in August, 1933, for a trial period of six months, the hours of work being day workers 42½ hours and shift workers 42 hours a week. In principle, except certain piece and bonus workers, a man received the same weekly rate for the shorter hours as he received for the longer hours, 46 to 48. The employers obtained certain concessions for week-end overtime in the process, and paid no extra time to the day workers. The comparative results for the six months before and six months after the inception of the scheme were :—The reduction in hours per person was 10 per cent., the increase in output was 15 per cent., the increase in the number of employees was only 8·4 per cent., and the output value per man went up by 11·4 per cent. The average weekly earnings were unchanged. The scheme had been adopted as a permanency, and if it was possible to apply the system to one part of the glass industry he suggested it was worthy of consideration by others.

The River Wey Drainage Scheme.

ON Monday, May 20th, the Chairman of the Surrey County Council, together with members of the River Wey Improvement Joint Committee and the Thames Conservancy Board, made an inspection tour of the river Wey drainage works between Weybridge and Farnham, which are to be completed at the end of June. The improvement scheme has entailed the clearing of obstructions in the 47 miles of river in Surrey and 17 miles of tributaries; the construction of eighty-one new cuts involving the excavation of some 280,000 cubic yards of land; the dredging of shoals; the construction of fifteen new weirs and sluices; and additions and improvements to four existing weirs; the provision of seventeen new foot bridges; and the construction or reconstruction of six highway bridges. Broadly speaking, only unemployed men have been engaged on the scheme, and the average number employed over a period of nearly five years has been 154. At a luncheon which took place at Farnham, Mr. J. Chuter Ede, the Chairman of the Surrey County Council, proposed the health of "The Thames Conservancy Board." In his reply, Lord Desborough said that when in 1919 the Board received a proposal to drain the river Wey and to throw some 600,000,000 gallons of water into the Thames, the scheme was received with very moderate enthusiasm. Fortunately, with the help of the Government and with contributions from County Councils, they had been able to embark on the scheme under the ægis of the engineer, Mr. G. J. Griffiths. It was a great thing that the schemes of draining the river and of dealing with the water were carried out under what one could call one supervising body. He could not say, however, that the danger of Thames flooding was over. The river would only take a flow of a certain amount of water—4,500,000,000 gallons in the twenty-four hours—without flooding. One inch of rain over the Thames catchment area was equal to a body of water 670 miles long, 250ft. wide, and 10ft. deep, and 1in. was therefore a serious matter to deal with.

The Albert Canal.

No. II.

(Continued from page 506, May 17th.)

The Caster and Vroenhoven Cuttings.

BETWEEN the Meuse valley and the Geer the cutting has been made in Maastricht tufa rock, a soft calcareous rock of fairly uniform character approximating to chalk. In this material the sides of the cutting can be made almost perpendicular. The tufa in this first deep cutting, known as the Caster cut, is overlaid by Meuse gravel to a depth of about 15 m. The cutting has a length of about 1·5 kiloms. and a maximum depth of 64·85 m. A typical cross section of the cutting is shown in Fig. 13, and views of it in course of excavation and in a finished state are reproduced in Figs. 15, and 24 and 26 on page 540. The sides of the cutting in tufa are battered at 1 in 4 or 3·3 (vertical) with benches at vertical intervals of about 10 m. The overlying sands and gravels are trimmed to slopes of about 1 in 1·5 (horizontal). The bottom width of the canal prism is 29·0 m. and the depth of water 5 m. The rock sides of the prism from tow-path level to the canal bed are faced with concrete, as seen in some of the views. The cutting yielded 8 million cubic yards of excavation.

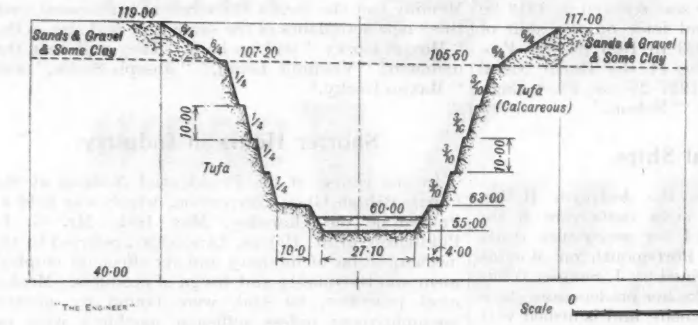


FIG. 13—CROSS SECTION OF CASTER CUTTING

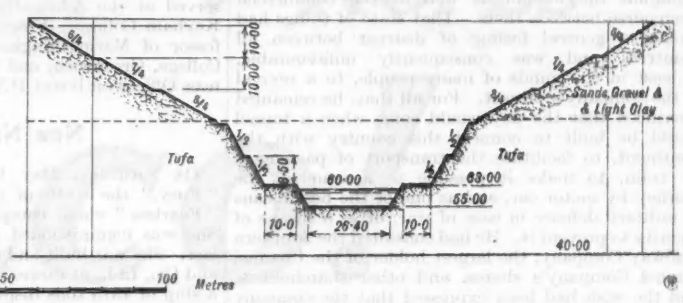


FIG. 14—CROSS SECTION OF VROENHOVEN CUTTING

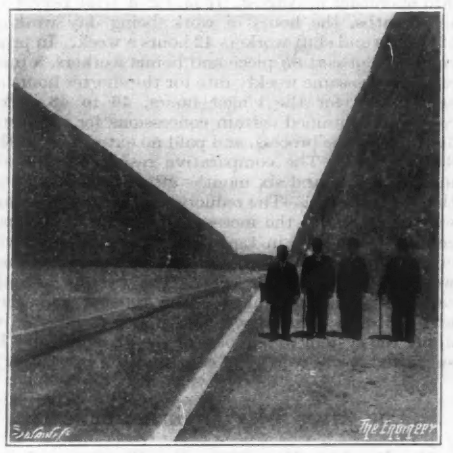


FIG. 15—CASTER CUTTING—MAY, 1934

The canal crosses the Geer valley (seen in the view, Fig. 26) at Canne, the stream being passed underneath the canal in a reinforced concrete syphon having a cross section of 10 square metres. Immediately after crossing the Geer valley, the canal enters the Vroenhoven cutting. In the first portion of this cutting the geological formation is tufa rock overlaid by beds of gravel and silt to depths of from 20 m. to 30 m. A section of the canal near Canne, where the cutting has a maximum depth of 60 m., is shown in Fig. 14. Further on the cutting is less deep and the tufa disappears, being replaced by sand, which changes into gravels as the canal is followed to the northward. Nearly the whole of the excavation between the Geer and Briegden, a distance of 8 kiloms., has now been carried out, the total volume of the excavation being about 18 million cubic metres. Throughout nearly the whole of its length the cutting lies close alongside the international frontier between Belgium and Holland. The total volume of excavation done between Lanaye and Lanaeken is 24 million cubic metres. A longitudinal section of the canal between Haccourt and Hasselt is reproduced in Fig. 16.

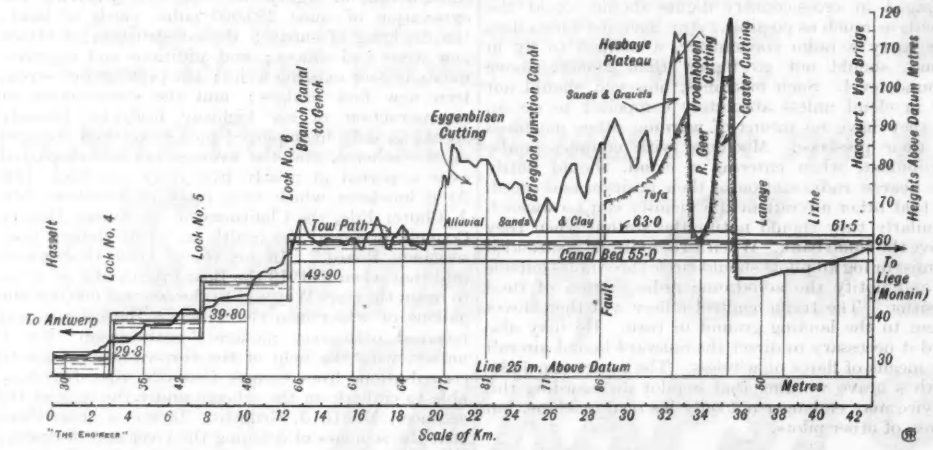


FIG. 16—LONGITUDINAL SECTION OF CANAL—HACCOURT TO HASSELT

Plant for Deep Cuttings.

The excavation of the deep cuttings between Petit-Lanaye and Vroenhoven and the disposal of the spoil in the time allowed for the carrying out of the work, entailed the provision by the contractors of an unusually large equipment of plant. The whole of the 24 million cubic metres of spoil had to be excavated and dumped within a period of 4½ years. In order to complete the work in the stipulated time it was necessary to start excavation at as many points on the line of the canal as possible, and this involved many miles of temporary railway track for the hauling of the spoil by various routes to the low-lying land in the Meuse valley. The disposal of spoil was speeded up by driving two tunnels through the chalk massif between the Meuse valley and the Geer valley to give access to working positions. In all, 6800 m. of tunnels were driven by the contractors for this purpose. Most of the excavation in the tufa (chalk) was done by steam shovels.

The plant employed on these cuttings included 115 kiloms. of railway track, 1125 spoil wagons, and 32 excavators of various types, mostly steam or Diesel-driven. The total value of the contracts for the cuttings between Petit-Lanaye and Briegden, and the construction of the canal in them and in the Meuse valley between Haccourt and Petit-Lanaye, is about 535 millions of Belgian francs. It is stated that between 50 and 60 million francs have been expended on plant for the excavation and disposal of the spoil from the cuttings. That section of the canal which lies between Haccourt–Visé and Hasselt (Fig. 16) includes the principal deep cuttings through the high plateau.

The Eygenbilsen Cutting.

The short section of about 4 kiloms. between Briegden and Eygenbilsen, which lies almost east and west, had at the time of our visit (January, 1935) not been begun. At Briegden a branch canal has been made to link the Albert Canal and the Maastricht-Bois-le-Duc Canal. It runs in a north-easterly direction for a distance of about 6 kiloms. to join the existing canal at Neerharen. The branch contains two locks, one at Lanaeken and the other at Neerharen, each of which has internal dimensions of 55 m. by 7·5 m., overcoming the total fall of 17·3 m. between the two waterways, and suitable for barges carrying 600 tons. This work was begun in 1932, and is now completed. The section of the main canal extending north-west from Eygenbilsen was begun in February, 1932, and is one of the most interesting and difficult works entailed by the construction of the Albert Canal.

FIG. 17—TYPICAL HALF CROSS SECTION OF EYGENBILSEN CUTTING

Although it was known that the nature of the subsoil in the neighbourhood of Eygenbilsen was likely to involve difficulties, both in excavation and in the maintenance of the slopes of the completed cutting, the plan now being carried out was adopted because its line is shorter and the excavation is of less depth than on any other feasible line. The level of the ground where the ridge is crossed is about +84·5 m. The canal bottom, before lining, is at +54·0 m., and thus the maximum depth of cutting is about 30 m. The excavation is almost entirely in alluvial sand and silt overlying soft clay. The supporting power of the silt, even when dry, is insignificant and slips on a considerable scale constantly occurred at the faces of excavation in the absence of adequate drainage.

The total length of the cutting for which contracts have so far been let is about 2000 m. The first contract, that begun in February, 1932, is now almost completed, and the description of the works which follows applies especially to this first section, having a length of about 1400 m. The second contract, placed in May, 1934, with the contractors who are responsible for the first section, is expected to be finished by the end of 1935. A third contract, not yet placed, will carry the deep excavation eastward

from the railway line near Eygenbilsen Station towards Briegden. This work involves a deviation of a part of the Hasselt-Maastricht railway, which at present occupies the site of a portion of the future canal near Gellick.

The strata excavated in the cutting comprise surface beds of water-saturated argilaceous sands, varying in thickness from 14 m. at the southern end of the cutting to about 5 m. at the northern end, under which is a bed of compact clay (Upper Rupel clay), which is practically impermeable and has a thickness of about 10 m. Below this again is a bed of fine sand only slightly argilaceous (Middle Rupel), 11 m. to 12 m. thick, which is sealed by the overlying clay and holds artesian water. Under the artesian sands and below the level of any part of the excavation is the Lower Rupel clay—Fig. 17.

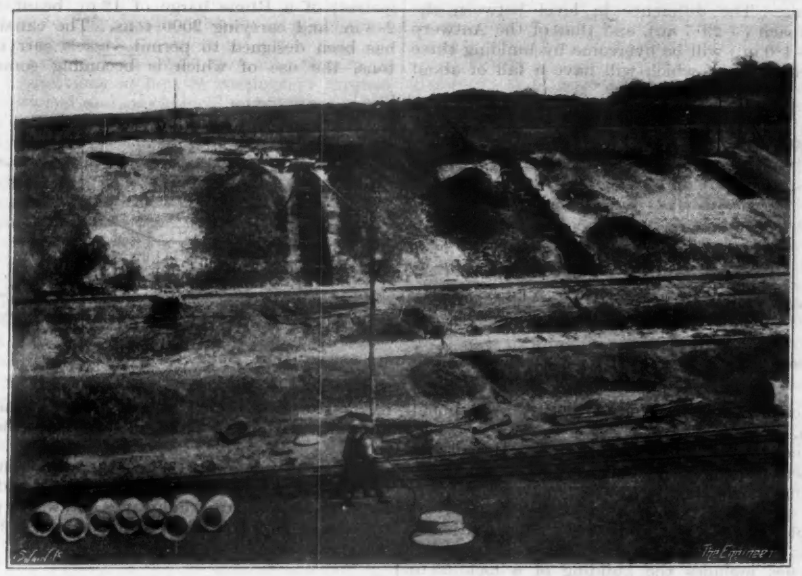


FIG. 18—EYGENBILSEN CUTTING—TRENCHING FOR SIDE DRAINS—JUNE, 1934

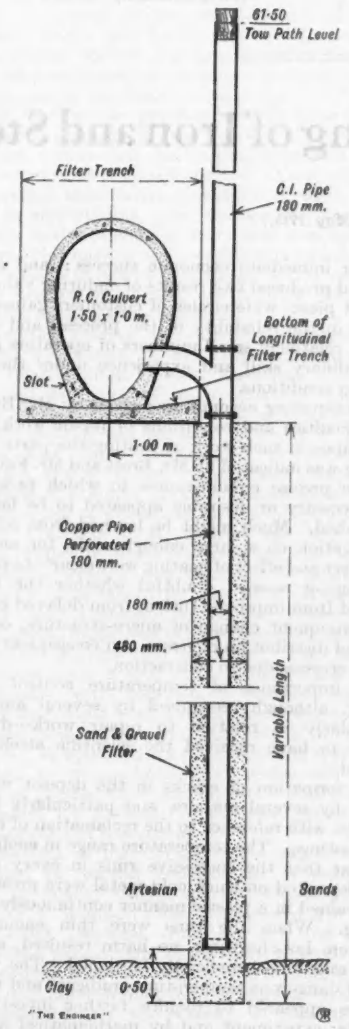


FIG. 19—FILTER WELL

To provide for the drainage of the sides of the cutting rubble drains were made, generally at right angles to the slopes and spaced about 15 m. apart. Some of these can be seen in the views (Figs. 25 and 27 on page 540) These drainage trenches were cut with a width of about 2 m. and carried down into the clay. At the base of each drainage trench is a small culvert for collecting and evacuating water at a level a little above that of the canal water surface. The trench at the sides of and above this culvert is filled with large gravel graded down to sand at the sides (Figs. 17 and 21).

To ensure the stability of the canal prism at the bottom of the cutting two wide tow paths are made, which, in effect, act as abutments to the side slopes. Each tow path has a minimum width of 10 m. and is enclosed between longitudinal drainage trenches parallel to the canal, that nearest to the canal prism having a minimum width of 1·6 m. and the other a minimum width of 1·4 m. At the bottom of each drainage trench is an egg-shaped culvert, that in the wider trench measuring 1·5 m. by 1·0 m., and the other 1·05 m. by 0·7 m. Rectangular slots are cast in every tenth culvert pipe near the level of the invert to permit the inflow of water. The culvert pipes are surrounded and the trenches filled with graded gravel and sand in the same way as the transverse drains.

Connecting pipes between the two trenches are provided at intervals of 50 m. and at every 400 m. is a cross drain under the canal, consisting of reinforced concrete pipes, 1·5 m. by 1·0 m., connecting the two sets of longitudinal trenches. Manhole shafts are provided at intervals of 50 m. on the longitudinal drainage culverts for the purpose of inspection. The drainage water ultimately collected in the deepest of the four egg-shaped longitudinal culverts flows by gravity to a stream (the Rocherbeck), situated at a convenient level (+50·0 m.) at Zangerheide, near the northern end of the cutting.

Beneath the clay, which forms the bottom of the canal prism throughout the greater part of the Eygenbilsen cutting, there is, as we have already mentioned, a layer of fine sand, much more permeable than the strata overlaying it, containing artesian water under a head which, before the commencement of the works, varied from about 5 m. above the canal bottom at the northern end to 18 m. at the southern end of the cutting. In a part of the cutting where the layer of clay remaining after excavation is too shallow to resist the upward pressure of the artesian water, filter wells have been sunk at intervals, usually of 15 m. In the first section of the cutting there are 109 filter wells in a length of about 1 kilom. (Fig. 19). Each filter comprises a boring tube, 480 mm. diameter, carried down to the clay bed beneath the water-bearing sand (Middle Rupel beds). In this outer tube is inserted a copper tube, 180 mm. diameter, the annular space between the two tubes is filled with graded fine gravel and sand, and the outer boring tube is then withdrawn. The copper tube, where in the water-bearing strata, is perforated with small holes, and water rising in the pipe is allowed to syphon into the longitudinal culvert pipes already described, and into the cross culverts beneath the canal bed. Two or more filter wells have been sunk on the line of each of the latter and discharge the water rising in them direct to the egg-shaped culvert. The copper tube of each of the filter wells in the canal banks is extended up to the level of the tow path by a cast iron pipe of the same diameter as the copper tube.

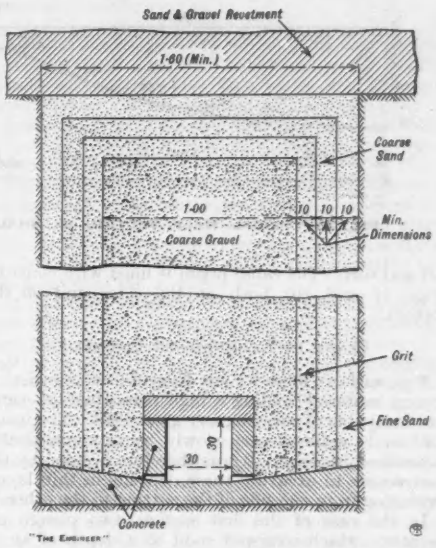


FIG. 21—TYPICAL CROSS SECTION OF CROSS DRAIN

The impervious clay forming the roof of the artesian sands would have been insufficient to resist by its own weight the upward pressure as the excavation of the

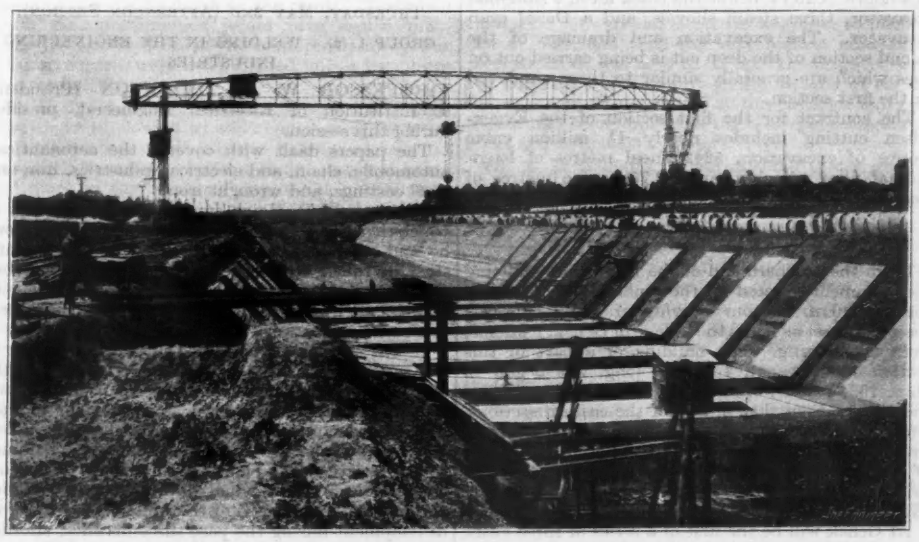


FIG. 20—EYGENBILSEN—CONCRETING CANAL PRISMS—MAY, 1934

cutting proceeded. During the progress of the work water was pumped from the wells and discharged at the lower or northern end of the cutting. By this means the artesian water level was lowered successively until it was below the bed of the canal cutting. As soon as the longitudinal pipe culverts, which together with the wells form a part of the permanent works, were available for the discharge of water by gravity to the lower end of the cutting, the water rising in the wells was allowed to flow into them. Observation wells were sunk at intervals along the line of the cutting and the water levels recorded in these enabled the pumping operations to be kept under effective control. In addition to the permanent filter wells, whose object is to relieve the pressure of the artesian water, small temporary filter wells were sunk in the alluvial surface deposits to assist the superficial drainage during construction.

So far the means adopted to stabilise the sides of the cutting and the canal bottom have met with complete success, and, in particular, the relief provided by the system of filter wells has effectually prevented any uplift or other displacement of the canal bed. Views of the work in progress in the Eygenbilsen cutting are reproduced in Figs. 18, 20, 25 and 27.

To protect the clay slopes of the excavation above the level of the tow paths from the effects of alternating dry and wet weather, they are covered with a layer 70 cm. thick of gravel and sand revetted with soil and turf. The canal prism is lined with concrete (Figs. 17 and 20), both at the sides and on the bottom.

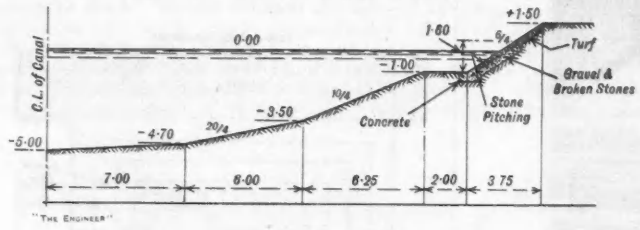


FIG. 22—TYPICAL HALF SECTION IN SHALLOW CUTTING

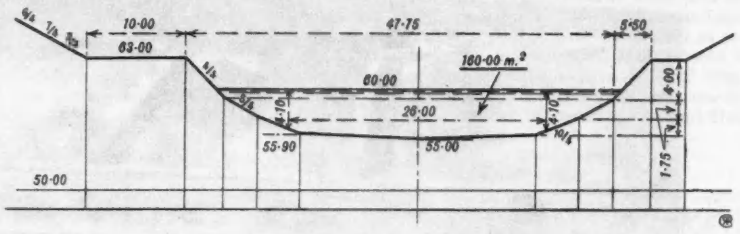


FIG. 23—TYPICAL SECTION IN DEEP CUTTING

PLANT IN EYGENBILSEN CUTTING.

The surface deposits at Eygenbilsen consist of spongy material holding a high percentage of water and incapable of carrying any great load. The water content is reduced very slowly by any practicable method of drainage. It was therefore decided by the contractors to excavate these deposits in thin layers extending from one side of the cutting to the other.

In the case of the first section, two plough excavators, which removed spoil to a depth of about 40 cm., were employed on this work. Each is fitted with a belt conveyor by which the excavated material is discharged into a caterpillar hopper wagon of 5 cubic metres capacity. The excavators are attached to Diesel caterpillar tractors of 60 h.p., which supply the power required for excavation and traction. The spoil wagons are also drawn by Diesel caterpillars, of which fourteen were employed on the works. Special grading machines were used for forming the side slopes of the cutting.

For the excavation of the clay beneath the surface deposits steam shovels and trains of spoil wagons, hauled by locomotives, were employed in the usual way, Fig. 27. Specially designed trench excavators were used for digging the longitudinal drainage trenches.

The plant employed on the second section of the deep cutting includes a Lübeck excavator working to a depth of 10 m. below the track level, a drag-line excavator, three steam shovels, and a Diesel grab excavator. The excavation and drainage of the second section of the deep cut is being carried out on lines which are generally similar to those employed on the first section.

The contract for the first section of the Eygenbilsen cutting includes nearly 1¼ million cubic metres of excavation, 5242 lineal metres of longitudinal filter trenches, and 22,750 cubic metres of transverse drains in the banks of the cutting.

EYGENBILSEN-HASSELT.

From the northern end of the Eygenbilsen cutting the alignment selected for the canal follows generally the +60·0 m. contour curving gradually towards the north-west as far as the village of Genck, 6 kiloms. from the cutting. The building of a part of this section of the canal, 4 kiloms. long, was begun in May, 1934; the work will be, relatively, much less spectacular than that in any of the eastern sections, which have already been described. In place of cuttings of great depth, there will be alternating lengths of low embankment and shallow cutting, the canal prism being of the normal section shown in Fig. 22.

At Genck will be the first of a series of three locks, none of which has yet been begun, by means of which the water level of the canal will be lowered from +60·0 m. to +29·7 m. in the Hasselt reach, an average of just over 10 m. fall in each lock. Genck will therefore be the western terminal of the level reach of the new canal, 38 kiloms. long, which, together with the canalised section of the Meuse above Monsin, 17 kiloms. long, having the same water level, will provide a waterway uninterrupted by locks or swing bridges for a total distance of 55 kiloms.

At Genck there will also be made a barge basin at the point where a branch canal, which will serve the collieries of Genck lying to the north of the Albert Canal, will make junction with the main waterway. Below Genck the canal will follow the Démer valley as far as Hasselt (+29·7 m.); this section, which includes the building of two of the three locks already mentioned, is of similar character to the section above Genck without deep cuttings. To the north of Hasselt the new canal will be superimposed on a reach of an existing branch canal which connects the town with the old Meuse-Scheldt Canal.

HASSELT-ANTWERP SECTION.

At a point about 23 kiloms. north-west of Hasselt the canal will diverge from the line of the existing branch canal, and, following a westerly line, join the main line of the old Meuse-Scheldt Canal near Herenthals. The difference in level between the Hasselt reach (+29·7 m.), and that of the Antwerp docks (+4·0 m.) will be overcome by building three more locks, two of which will have a fall of about 10 m. each, and the third, and lowest, at Wyneghem, of 5·7 m.

The constructional work of the Herenthals-Wyneghem reach, 15 kiloms. long, including the connecting link above Herenthals between the new and the existing canals, was begun in 1932 and will be completed in 1935. This section, in addition to the locks on the main waterway, to which we shall again refer, includes the building of a lock 55 m. by 7·5 m., with a fall of 7·35 m. as a part of the connecting link with the old canal and another lock, 81·5 m. by 10·5 m., to form a connection with the Lesser Nèthe at Viersel.

The Wyneghem lock and the reach of the canal below it, 7 kiloms. long, which connects with the docks at Antwerp and the river Scheldt, have already been completed and are open to traffic.

NORMAL DIMENSIONS OF CANAL PRISM.

The normal sections of the canal cutting are as shown in the cross section, Figs. 22 and 23; a typical section in shallow cutting is reproduced in Fig. 22. The minimum bottom width in the normal prism is 26 m., and the depth of water on the centre line 5 m. reduced to 3·5 m. at a distance of 13 m. from the centre line. The slope of the canal sides below water is generally 4 in 10. The cross-sectional area of the normal water prism is 160 square metres, or five times the immersed cross section (32 square metres) of a Rhine barge of 12 m. beam, drawing 2·8 m. and carrying 2000 tons. The canal section has been designed to permit vessels carrying 1350 tons, the use of which is becoming common, to navigate at full speed, the ratio between canal section and immersed cross section in the case of these being 6·6.

At a depth of 1 m. below the water surface on both banks of the canal is a berm, 2 m. wide, whose object is to break up wind waves and waves produced by passing vessels. When the canal is in deep cutting the side berms are suppressed.

In Fig. 1 on page 504 of our issue of May 17th the following navigations should have been indicated by double lines to agree with the legend on the map, which reads "Existing Canals and Rivers Suitable for 2000-ton Rhine Barges":—The whole course of the river Rhine; the Waal down to Rotterdam; the Meuse above Monsin; the Gand-Terneuzen Ship Canal; and the waterways traversing the land north of the Schelde Estuary.

(To be continued.)

Symposium on the Welding of Iron and Steel

No. II.

(Continued from page 509, May 17th.)

THURSDAY, MAY 2ND (AFTERNOON SESSION).

GROUP I. (B). WELDING IN THE ENGINEERING INDUSTRIES.

PROFESSOR W. M. THORNTON (President, Institution of Electrical Engineers), presided during this session.

The papers dealt with covered the aeronautical, automobile, chain, and electrical industries, iron and steel castings, and wrought iron.

Professor B. P. Haigh summarised the papers, of which there were twenty-seven in the group. Interest, he said, centred around the electric welding of mild steel in rolled sections, forgings and castings, but extended also to wrought iron and high-tensile steels, and to cast iron in certain applications. The papers dealt with repair work as well as new construction.

It was significant, he said, that the first paper in the series—by Mr. J. E. Fletcher (Dudley) on the Welding of Wrought Iron—dealt with a process and industry older than written history, *i.e.*, the production of wrought iron by puddling, and it was no less significant that that established industry was quick to appreciate and advance with science. The contrast between the gradual development of welding through the long course of the iron age and its rapid development during the past three decades, afforded a striking example of the influence of scientific, technical, vocational, and even primary education. Our times differed from earlier periods chiefly by reason of education.

It should not be forgotten that modern welding processes were based on the initiative of a relatively small number of individuals, who, with insight and courage, foresaw the changes that might be accomplished and undertook the work of development in its early stages. The papers presented gave a remarkable record of successful achievement and revealed certain difficulties that temporarily retarded progress in particular directions. It was clear that the development of welding was not yet complete.

Coming to repair work and the reclamation of faulty castings in steel or grey cast iron—dealt with in papers by Mr. V. C. Faulkner (Institute of British Foundrymen), Mr. V. G. Pearson (Edgar, Allen and Co., Ltd.), Mr. A. M. Roberts (Metropolitan-Vickers Electrical Company, Ltd.), and Mr. C. W. Brett (Barimar, Ltd.)—he said that in the early development of electric welding, repair work provided a field for immediate economic success; and experience had produced two results of enduring value. In the first place, wide circles of customers gained confidence in the reliability of the process, and in the second, relatively small numbers of operators gained extraordinary skill and experience under the most exacting conditions.

An interesting account was given by Mr. Brett of the difficulties and conditions of repair work. The importance in such work of heating the parts before welding was indicated by Mr. Brett and Mr. Faulkner, but the precise circumstances in which preheating was necessary or desirable appeared to be far from established. Much might be learned from scientific investigation on a large enough scale, for although the object and effect of heating were clear—to prevent cracking—it seemed doubtful whether the benefit resulted from improved fusion, from delayed cooling, and consequent change of micro-structure, or from modified distribution of strain and consequent reduction of stresses due to contraction.

The importance of temperature control during cooling, although recognised by several authors—particularly in relation to repair work—did not appear to have received the scientific attention it merited.

The formation of cracks in the deposit was discussed by several authors, and particularly by Mr. Roberts, with reference to the reclamation of massive steel castings. The temperature range in cooling was so great that the successive runs in every electric weld deposited on thick cold metal were presumably self-strained in a plastic manner continuously during cooling. When the runs were thin enough and free from hot-shortness, no harm resulted, and the metal might be beneficially hardened. The production of dangerous temperature gradients and thermal stresses appeared to require further investigation, both by experiment and by mathematical analysis. The subject lent itself to mathematical expression, and the practical importance of the term $E\alpha$ (which for steel was about 1 ton per square inch per 7 deg. Cent.) should be taught in every university and technical college. The terms $E\alpha/1-\sigma$) and $E\alpha/(1-2\sigma)$—which were not only greater in numerical, but also in practical importance—should also be more generally familiar in relation to cooling stresses.

In spite of the success attained in repair work, the

use of welding in the reclamation of faulty castings was long regarded as improper, and that attitude might still be justified as the process provided a means of covering as well as of repairing faults. If reclamation were permitted, that sign of increasing confidence might be welcomed and appreciated as a high tribute to honest capacity for taking pains. Professor Haigh considered that electrodes should be selected, not wholly for technical excellence as indicated by test figures, but also by their ability to facilitate reliable work.

Several papers dealt with the construction of massive fabrications in lieu of castings or forgings for the electrical and mechanical engineering industries. It was notable that substantial arc welds were commonly called upon to stand tensile and shear stresses as severe as could be transmitted to them by mild steel plates of good quality, and it was reassuring to know that when such joints were tested to the yield point, the plates and rolled sections usually suffered severely before the welds revealed any sign of injury. One of the many interesting features in a paper by Mr. R. G. Griffin (Australia), describing an electrically welded mobile crane for heavy duty, was an illustration of the results caused by a collision—no weld had fractured, although the members suffered calamitous distortion.

In recent years much ingenuity had been directed to arranging large and important "weldings" in special ways so that the joints should be free from severe tensile stresses, but it was believed that general experience as well as laboratory investigation indicated that no such inconvenient restrictions were necessary.

Warping, caused by contraction during cooling, was discussed from different points of view by several authors, and doubtless would long continue to require detailed consideration in individual cases. Sequence of assembly required careful study, and an example of considerable interest was given by Mr. H. S. Bavister (Vauxhall Motors, Ltd.).

Warping, when it was evident, occurred most commonly immediately during cooling, and—in the case of many weldings in machinery—was eliminated during subsequent machining operations. In more severe cases, however, further warping might occur during machining or in subsequent service. The successes attained in the construction of stators and rotors for electrical machinery, described by Mr. E. C. Davies (General Electric Company, Ltd.), Mr. J. A. Dorrat (Metropolitan-Vickers Electrical Company, Ltd.), and by Mr. H. W. Hawkins and Mr. J. Donkin (British Thomson-Houston Company, Ltd.), afforded valuable evidence that warping could be overcome by reasonable precautions.

Mr. E. F. Spanner (Spanner Thimble Tube Boilers, Ltd.) called attention to the progress of arc welding in marine engineering and shipbuilding, and to the special conditions of marine service. It was encouraging to reflect that in the application of welding processes in shipbuilding, our country had been continuously active from the start and was still pre-eminent. Not only in new construction and in repair yards, but also in repairs necessarily carried out under adverse conditions at sea, arc welding should be invaluable to the marine engineer.

Automatic welding by different processes was discussed by Messrs. S. W. Carpenter and A. L. Guest (Metropolitan-Vickers Electrical Company, Ltd.), and in many of its applications by other authors. Chain production by different methods of resistance welding was discussed by Mr. T. F. Holden (Holden and Hunt, Ltd.), and by Messrs. V. Napravnik and S. Popov (Czechslovak Mining and Iron Works Company), and chain welding as well as other examples of welding in mine haulage was dealt with by Professor J. H. Andrew and Mr. W. A. Johnson (Safety-in-Mines Research Board).

Resistance welding was discussed in relation to automobile construction by Mr. J. C. Arrowsmith (Pressed Steel Company of Great Britain, Ltd.), and the special plant used in repetition work exhibited features of interest and promise. The rapidity of action required in spot welding had been attained automatically with conspicuous success, and the effect of that rapid action upon the strength of the metal had been investigated in detail in interesting examples. It appeared that spot welding was likely to extend in its application to plates and rolled sections of greater thickness, and that that development called for research in different directions—both practical and theoretical.

The welding of high-tensile steels was discussed, in relation to aircraft construction in particular, by Mr. H. Sutton (Royal Aircraft Establishment), and Mr. J. B. Johnson (War Department Air Corps, Wright Field, Daytona, Ohio, U.S.A.), and it was notable that certain high-tensile steels welded readily with complete success. The use of welding in connection with aircraft had become very general, and was remarkable for the variety of material and method, and for the ingenuity and theoretical character of the mechanical designs involved.

Atomic hydrogen welding was described by Messrs. S. W. Carpenter and A. L. Guest, and its application in aeronautical industries was dealt with by Mr. J. B. Johnson. Magnetic methods of testing, dealt with in other papers, were also of special interest.

Discussion.

Mr. G. R. Grange said that machines were available by which a flange could be flash welded on to solid drawn steel pipes up to 8in. diameter at a cost of about 2d.

Mr. B. Bonell (General Electric Company, Ltd.) said that whilst it was generally agreed that it was in the constructional details of large machines that electric welding had won a prominent position and had its widest application, it was not wise to accept such a method *in toto* as a regular workshop practice, because there were instances where cast iron was more suitable than a welded structure. Thus, the designer should be allowed full discrimination in his choice. Two examples of this were, first, the split stator of a horizontal A.C. machine of large diameter and narrow width, and secondly, guard plates of some high-speed machines. The first essential of a stator of a machine was that it should be absolutely rigid; the fabricated structure might be stronger, but it was more flexible and subject to vibration. Again, each half of a horizontally divided stator must be considered as a thin metal arch, and as such very easily distorted during slinging and handling on its journey to site. Such deformation usually rendered necessary a subsequent alignment, which had to be corrected by heat treatment, and that might not be convenient. In the case of guard plates, there was the danger of humming owing to the speed of the air in a fan-ventilated machine, and there was also more danger, with a light sheet metal guard, of its natural period synchronising with the natural period of the machine, causing resonance and setting up excessive vibration in the guard. That effect had been experienced on a large high-speed vertical alternator.

With regard to the flame-cutting of plates 5in. or more in thickness, apparently one of the effects was to form a series of small cracks which, if not machined off quickly, were likely to spread inwards. He asked if they could be avoided by methods such as preheating the plate before cutting.

Too much emphasis was given to the appearance of the fabricated structure. The modern fabrication method had come to stay, and should not be limited to producing machines on past conventional lines. Engineers were becoming convinced of its adaptability and advantages, even in its æsthetic respects.

Mr. J. F. Cuss (Air Speed, Ltd.) said that up to the present the minimum thickness of tube that it was considered practicable to weld was of the order of 20 gauge—about four-hundredths of an inch; but he had obtained fairly satisfactory results in the welding of materials of about two-hundredths of an inch thick. Tests were made on $\frac{7}{8}$in. diameter, 24-gauge tubes welded in the form of a plain joint—a typical fuselage joint. The material under test had given values above the minimum specified for the welded strength of such material, but so far such a joint was not approved.

Discussing the fact that nearly all such welded joints were required to be reinforced by plates—for example, if there were three tubes meeting, plates had either to be let into the tubes or welded alongside them—he expressed the opinion that that practice sometimes led to fractures at the joints. Tests had shown that unreinforced joints gave results practically as good as those of the reinforced joints; but so far structures were not accepted unless the plates were used at the joints.

Dr. H. J. Gough said that at first sight many engineers might think that whether chains were made by the hand process or the electric welding process did not matter very much, because chains were not being used much in engineering owing to the introduction of wire ropes. But those in close contact with the industry knew that for a considerable period, and certainly so far as we could look ahead, chains would be required; and he was disappointed that the contributions from British chain manufacturers were practically negligible, there being only one paper from actual manufacturers of chain in this country. But one might be misled by the paper contributed by V. Napravnik and S. Popov, of Czechoslovakia, the gist of which was summed up in their statement that, provided suitable material was chosen, electrically welded mild steel chains were just as good as wrought iron chains made by the fire welding process. There were manufacturers in this country producing electrically welded chain up to about $\frac{1}{16}$ths (such as was used for pulley blocks) better than that produced in any other country in the world; it was also within his knowledge that from a size of $1\frac{7}{8}$ and up to $4\frac{3}{4}$ and $5\frac{1}{2}$, owing to a really wonderful development in the Black Country, we were making chain immeasurably better than that of any other country in the world. On the other hand, in the gap between $\frac{1}{4}$in. and $1\frac{7}{8}$in., America, Germany, France, Belgium, and Czechoslovakia at least were turning out electrically welded chains on mass production lines. In this country, so far as he knew—and he was in a very good position to know—there were no firms who would dare to produce chain above $\frac{1}{4}$in. size in that way and expose it to international competition. That would not matter very much, except that there was a grave danger of the British chain trade dying out. Apprentices were not entering the trade, and unless real steps were taken in this country during the next few years we should find that the chains of the sizes within the gap he had mentioned would either be made by hand in this country or imported from abroad. Steps were being attempted to remedy that in certain circles. But he and his colleagues had subjected various chains to the most rigorous tests, and the results would be published in a few months. It was true, as stated in the Czechoslovakian paper, that one could produce electrically welded mild steel chain as good as any hand-made wrought iron chain; but he did not believe that, above a certain size, it was being produced commercially, and he had knowledge that certain samples had come to this country which could not be produced commercially and yet give good results. One could obtain the best results, and one could obtain shocking rubbish, by that method. It must not be imagined that if one decided to change over from wrought iron to electrically welded chain one had simply to send an order and that the chain received would be as good as wrought iron chain; the chances were that in ninety-nine cases out of a hundred it would not be.

Mr. V. G. Pearson (Edgar Allen and Co., Ltd.) was concerned lest the paper by Mr. A. M. Roberts, dealing with the sound repair of steel castings by welding, should lead to the fear that there was something extraordinary in the welding of such castings; he emphasised that there was not, and that more than 75 per cent. of the steel made in this country was of weldable quality.

He suggested that although cracks could be traced magnetically in the laboratory, the application of that method to 10 or 20-ton castings would be rather difficult. It was his practice to machine, polish, and etch and to take sulphur prints, and he asked whether that was as good as the magnetic test.

It had been suggested that if an area of a casting were affected by segregation one should first apply a very high-grade electrode, and later should resort to another type, if thought fit. But he did not consider that that was the right procedure; if a casting had to be repaired one should use the best possible material throughout for the purpose.

Discussing means of preventing distortion, Mr. Pearson referred to a hydraulic cylinder, with walls $2\frac{1}{2}$in. thick, which had begun to leak after many years of service. A piece, nearly 20in. long and 12in. wide, was removed from the wall, and a plate $2\frac{1}{2}$in. thick had to be welded in. The procedure he adopted was to employ a welder on each side, each man putting down the same amount of weld metal. But it was very important to preheat; after each side was welded the contractional strain was removed from the cylinder and then the top ends were finished and the work was heat-treated again.

Mr. J. A. Dorrat (Metropolitan-Vickers Electrical Company, Ltd.), replying to Mr. Pearson on behalf of Mr. A. M. Roberts, said the steel castings with which his company were concerned were for turbines, in which pressures were reached up to about 1000 lb. per square inch. Castings for very high temperatures and pressures must be as nearly perfect as one could get them, but unfortunately they were not always sufficiently perfect. They had to do something to practically every casting they obtained. Wherever a defect occurred the hole was dug out and repaired with a special electrode developed by a special technique for use on high-pressure and high-temperature castings. This special electrode was used to line the slot or hole, and then the very highest grade mild steel electrode was used to fill up. He disagreed with the suggestion that the magnetic method of testing for cracks would not do for 20-ton castings, and said that it had been applied to big castings, such as turbines and hydraulic cylinders.

Mr. E. T. Williams (Admiralty) felt that engineers might consider without hesitation the application of electric welding wherever they had the opportunity. In his experience, wherever its application had been wisely extended, it had proved to be an advance in the right direction. Some firms in this country were not yet alive to the importance of this new development, and he was afraid that some of them would awaken when they had fallen very far behind in the new art of fabricated structures. But he emphasised that reliability was the first consideration, and urged that the welders must be properly trained and must work under proper supervision, and that the right electrodes must be used. The fabricated structure lent itself quite legitimately to savings in weight, space, and cost. He warned the enthusiast, however, that, realising the possibility of effecting savings, he must be careful to avoid overdoing it and running into trouble.

Mr. T. A. Swindell (Dorman, Long and Co., Ltd.), who had presented a paper with Mr. E. C. Moore, on welding fabrication for heavy engineering, said that his firm had been responsible for manufacturing and marketing during the last three years, 11,000 tons of steel weldings, comprising 30,000 machine parts. The problems confronting fabrication by welding were no more serious than those confronting fabrication by other processees, and he and Mr. Moore deprecated the seeming mystery which surrounded the welding process. The idea underlying their paper was to dispel such mystery. The decision as to the type of electrode to be used was not difficult. They used 60 per cent. of bare wire and 40 per cent. covered electrodes. They had had difficulties with all electrodes, and suggested that the electrode makers should put forward tests and indicate results by laying down beads of welding on pieces 6in. thick. He supported Professor Haigh's point that more attention should be paid to the rate of cooling. His own experience was that whenever he could reduce the cooling rate he had more chance of success in welding; because of

that consideration he had put in welds by means of a bare wire electrode and found that they would not crack under tests normally applied, whereas welds made with every other electrode he could buy had cracked.

Warping did constitute a real difficulty, as Prof. Haigh had mentioned, and when his company had first manufactured gear wheels those wheels had warped. The process then was to make the rim completely as a circle by welding, and to weld the other parts to it. But the difficulty was overcome quite easily; the subsequent practice was not to weld the rim completely until the spokes had been welded. Provided one did not attempt to weld a steel with more than 0·3 per cent. carbon, no trouble would be experienced; above that carbon content difficulties might arise, and precautions in respect of annealing would be needed.

With regard to cracks appearing in the edges of steel after burning, he said he had examined, under the microscope, pieces of steel which had been cut with a flame, and they had shown slight cracks behind the edges; but they extended only a very short distance into the steel, and the removal of $\frac{1}{16}$in. from the surface would get rid of them.

Dr. M. L. Kahn (General Electric Company, Ltd.) suggested that the advantages of the process of fabrication had not been fully explored; but if it were followed to its logical conclusion it must be apparent that it enabled the whole construction of stampings and casing to be built up as a single entity, and that by so doing a very large amount of machining operations could be dispensed with, whilst the resultant structure would be stronger and more durable than constructions in which cast iron had been used. That was only possible if a sequence of building was adopted where the stampings of the electrical machinery were assembled in a suitable jig and the fabricated structure built round it, again by using suitable jigs. With that method it was even possible to machine parts like feet, or other facings, before the complete structure was assembled, which avoided the handling of heavy parts and the use of large machine tools, such parts being adjusted entirely by the use of suitable jigs. A further advantage was the durability of the structure, as loose cores could not possibly occur with a properly designed construction.

The dimensions of casings on electrical machinery were not determined by breaking stresses, but only by deflection. The mere substitution of steel for cast iron or cast steel for constructions did not reduce the deflection. On the contrary, the deflection of a steel structure of given dimensions was greater than the deflection of a cast iron structure of the same dimensions.

The meeting adjourned until Friday.

(To be continued.)

The Twenty-four-Foot Wind Tunnel at Farnborough.

No. V.

(Concluded from page 518, May 17th.)

The Fan Drive.

THE 30ft. diameter fan by means of which the air current is established and maintained in the tunnel is situated just beyond the smaller end of the bell-mouth at the collector end of the tunnel. It is driven by a variable-speed direct-current motor developing a maximum of 2000 s.h.p. at 250 r.p.m. The motor, as stated in our second article published in our issue of April 12th, is arranged in a motor house adjoining the end wall of the tunnel building. The shafting, Fig. 30, coupling the motor to the fan has an overall length exceeding 64ft. It is 10in. in diameter and is in six lengths all of which, except the portion at the fan end, are bored out to 4in. Supports for the shafting are provided at three points, namely at two inclined streamlined struts close behind the fan, at the straightening fins which serve to reduce or eliminate the whirl imparted to the air stream by the fan and at the bank of deflectors which turns the current through its first right-angled bend. At the first named of these points twin bearings are provided. Hence, counting the two supports for the motor armature shaft, there are six bearings in all on the line. At each of these bearings there is a pyrometer which works in conjunction with a Cambridge motor-driven recorder giving consecutive half-minute readings of the temperature. Provision is made to accommodate a total longitudinal variation in the length of the shafting of 0·23in. arising from temperature changes.

The moment of inertia of the fan being determined by its aeronautical design and the length of the shafting being fixed, the design of both the motor and of the shafting was influenced by the necessity for keeping the natural torsional oscillation frequency well above the maximum speed. To that end the contractors entrusted with the supply of the fan-driving equipment, the British Thomson Houston Company Ltd. of Rugby, installed a motor designed to have a low moment of inertia and having an armature shaft of the shortest possible length. The length of the armature shaft was reduced by the employment of a Michell combined thrust and journal bearing at the driving end. At the commutator end a plain journal bearing with disc and wiper lubrication is used. A section of the driving motor is given in Fig. 31. The motor armature has a moment of inertia of $7{\cdot}2\times10^6$ and the fan one of $25{\cdot}9\times10^6$ in terms of pounds (weight) and inches.

The method of erecting the motor and shafting involved some features of interest. On the floor of the main building datum level and centre line insertions were provided and from them the inclined struts and the girder base on which they rest were set in position before the collector end of the tunnel was constructed. From the pedestal which was to carry the motor in the motor house a lining-up wire was stretched to a support beyond the inclined struts, the tape measurements taken from it being checked by means of a dumpy level. The inclined struts and girder base having been correctly located the bearing at the top of the struts was used to strike out the circular concrete throat of the tunnel. After the concrete straightening fins had been constructed the semi-circular steel shell stretching from the inclined struts to the straighteners, and subsequently enclosed within the sheet metal fairing shown in Fig. 14 *ante*, was erected and levelled. The three bearings resting within the semi-circular shell were then mounted in position on the same shiming as used in the factory set-up. After these bearings had been levelled the height of the lining-up wire was adjusted at the motor pedestal end by checking its height above the three bearings. A final check after the shafting had been completely erected by the addition of the bearing at the deflectors showed that over the whole length the line-up was correct to within 0·02in.

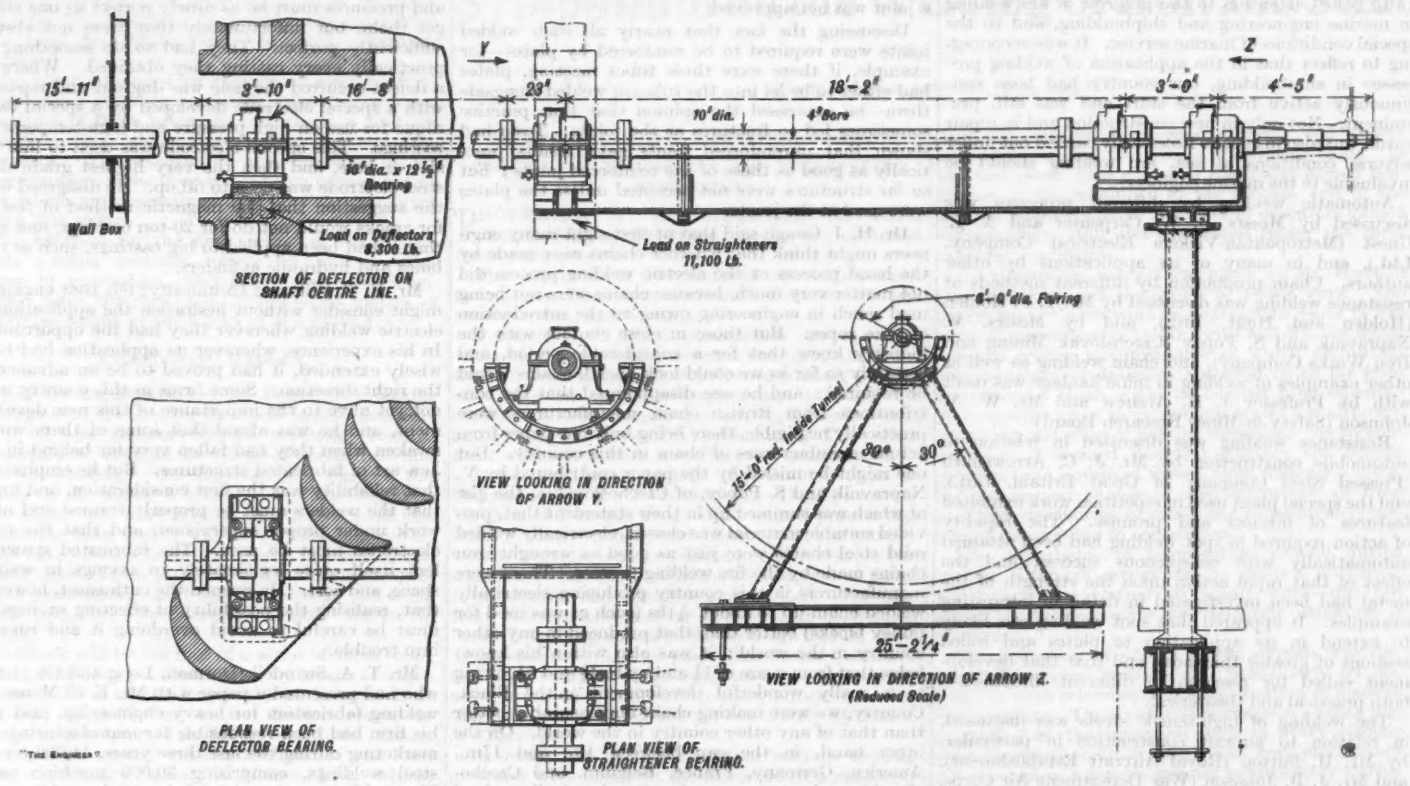


FIG. 30—GENERAL ARRANGEMENT OF FAN SHAFTING

The Electrical Equipment.

It was required that the speed of the 2000 s.h.p. motor should be closely controllable over the range from 250 r.p.m. down to 20 r.p.m. The supply available was direct current at 500 volts and it was therefore decided to adopt a direct-current booster control scheme. To this end there was installed a motor-generator set consisting of a 750 h.p. 500-volt compound-wound motor directly coupled to a 525 kW compound-wound booster with a reversible shunt field giving a voltage range from −465 to +250 volts. This set runs at 1000 r.p.m. and is fitted with an overspeed device. By means of the booster voltage a variable voltage ranging from 35 to 750 volts was obtained for the control of the fan motor speed, the motor-generator set required being much smaller than would have been necessary on the Ward-Leonard system.

In Fig. 32 we give a simplified diagram of the electrical connections for the fan motor and the booster machines and also for the speed-control system employed. To start the machines push-button control had to be provided at three points namely in the motor house, at a control panel—see Fig. 33 and also Fig. 12 *ante*—on the jet orifice wall adjacent to the observers' cabin, and at a second control panel higher up on the same wall within reach of operators on the model balance car. Contactor-type starting gear—see Fig. 34—was therefore installed.

The motor-generator set is started by the resistances R Fig. 32 which are cut out under current-limit control by the contactors 2 to 6. The fan motor is started on minimum voltage with resistance R 1 and contactors 7 and 8. Interlocking is provided to ensure that the generator set is running and

developing its full voltage before the fan motor line contactor 7 can be closed; but these circuits are not included in the diagram. For controlling the speed of the fan motor two motor-operated rheostats are employed; one, designated the "coarse" rheostat, is of a reversible potentiometer pattern

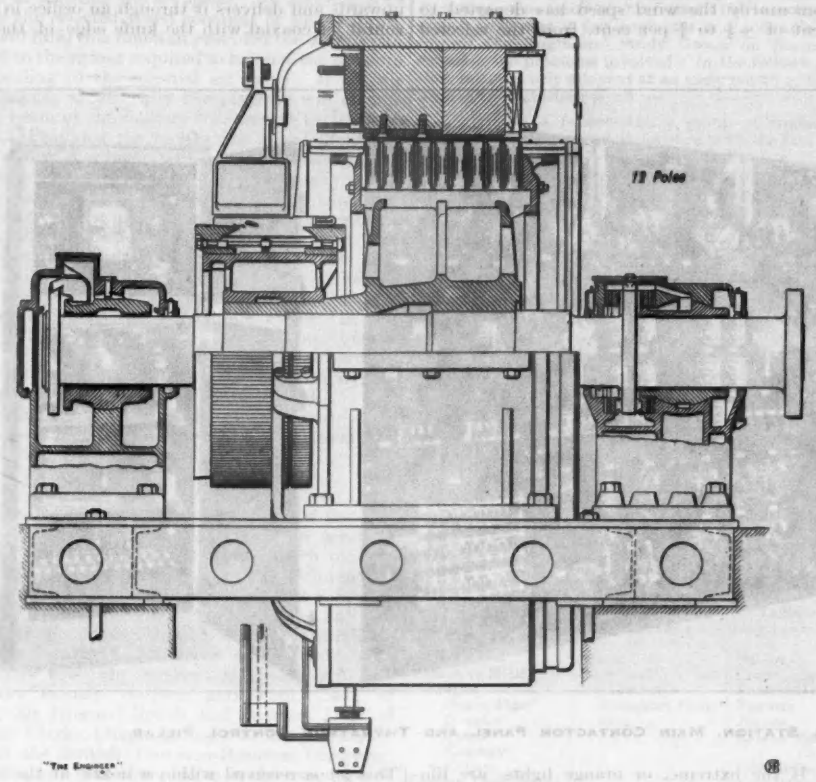


FIG. 31—2000 S.H.P FAN MOTOR

and is connected to the booster field; the other, called the "fine" rheostat, is a series-type rheostat connected in the fan motor field. The "coarse" rheostat is used for starting and rough adjustments of speed, while the "fine" rheostat is intended to give either accurate speed setting by hand control or automatic maintenance of wind pressure by means of the manometer control described later.

Remote control of these rheostats had to be combined with means to indicate at the control point the speed obtained. For this purpose both rheostats are fitted with selsyns, *i.e.*, small electrical machines having three-phase stators and single-phase salient pole rotors, working in conjunction with similar selsyns fitted to dial-type indicators on the control panels. In the case of the "coarse" rheostat the selsyn at the indicator end forms the transmitting unit, and is moved by a hand wheel, which, at the same time, sets the pointer on indicator B to the desired speed. The receiving unit on the rheostat then, by means of a thyratron system of control, described below, causes the rheostat arm to move and take up a position corresponding to the speed setting of the indicator. In order to give greater accuracy and to avoid hunting of the rheostat, the selsyn system actually consists of two pairs of transmitters and receivers suitably geared to produce a vernier control so that in effect the rheostat arm is moved rapidly to its approximate position, and then approaches the final accurate setting at a reduced speed. In the case of the "fine" rheostat the selsyn S 1 on the rheostat is the transmitter and S 2 on the indicator is the receiver. For hand control the operator in this case moves a control switch C to run the pilot motor of the rheostat in one direction or the other, according to whether the speed of the fan is to be raised or lowered, and the selsyns cause the pointer of the indicator A to follow the movement of the rheostat arm. For automatic control the movement of the pilot motor is effected by the manometer contacts D.

The resistances of the "coarse" rheostat are graded to limit the speed change per stud to within 2 per cent. at any point of the full range, while those of the "fine" rheostat limit the speed change per stud to within one-quarter of 1 per cent. over a 15 per cent. range. The speed of operation of these rheostats is independently adjustable by hand rheostats, not shown on the diagram, which control the voltage applied to the pilot motors, and in each case the pilot motors are energised under thyratron control, as stated above. The industrial application of thyratrons was discussed in an article in THE ENGINEER for August 10th, 1934. It will therefore on this occasion be sufficient to say that a thyratron is a mercury vapour electron-discharge device requiring negligible power to control its conductivity. Since it performs the function of a switch with no moving parts, it is particularly suitable for use in applications, such as this, in which instantaneous response is essential and frequent operation has to be sustained.

For controlling the "coarse" rheostat, four thyratrons, T 5, T 6, T 7, and T 8 are used, giving coarse and vernier adjustment of the rheostat in either direction of rotation. These thyratrons are controlled by the selsyns S 3, S 4, S 5, and S 6 in the following manner. The selsyn stators are interconnected in pairs, as shown, and the rotors of S 4 and S 6 are excited from an auxiliary A.C. supply, so that except when the rotors of S 3 and S 5 are 90 deg. out of phase with those of S 4 and S 6 respectively, voltages will be induced in the rotors of S 3 and S 5 which are connected as shown to the grid

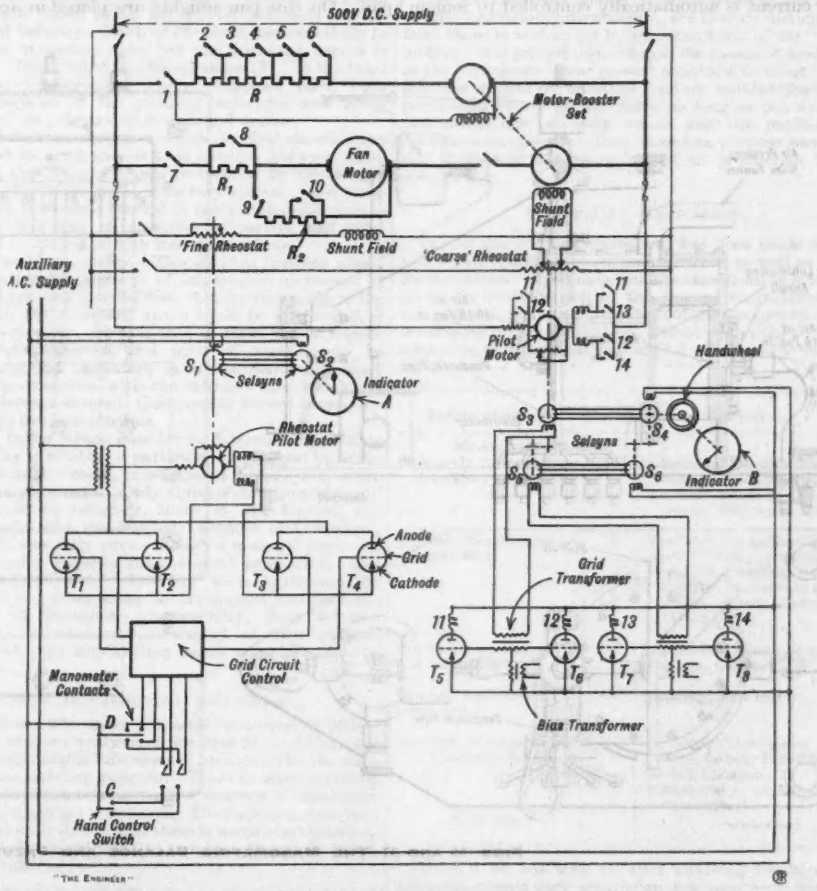


FIG. 32—SIMPLIFIED DIAGRAM OF FAN MOTOR CONTROL SYSTEM

transformers of the thyratrons. When the hand wheel is operated therefore to raise the speed of the fan, the phase and voltage induced in the rotor of S 3 will be such as to cause T 5 to conduct and the anode current will operate relay 11, which, in turn, will energise the field of the pilot motor and operate the rheostat to increase the voltage applied to the fan motor, until S 3 is again 90 deg. out of phase with S 4. When S 3 and S 4 have thus given the approximate setting, the other pair of selsyns S 5 and S 6 will still be sufficiently out of phase, because of the gearing between the pairs, to cause T 7 to conduct and operate relay 13. The movement of the rheostat will thus be continued until S 5 and S 6 are also 90 deg. out of phase. Similarly, if the hand wheel is moved in the opposite direction to lower the speed, the phase of the induced voltage will be reversed, and consequently thyratrons T 6 and T 8 will be controlled by the selsyns. These thyratrons are associated with relays 12 and 14, which cause the pilot motor to move the rheostat in the reverse direction. While relays 11 and 12 are in control, 13 and 14 are held out of action electrically, and the speed of movement of the rheostat is automatically reduced when approaching the final setting under the control of relays 13 and 14. It follows that if the hand wheel is only moved a small amount, only the vernier control, *i.e.*, T 7 and T 8, will respond, but if a large change in speed is called for, both the coarse and vernier adjustments will be made in sequence.

For controlling the "fine" rheostat the thyratrons serve as rectifiers for supplying the rheostat motor with rectified current from the A.C. supply. Full-wave rectification is employed, so that two thyratrons are necessary for both forward and reverse running. In the diagram T 1 and T 2 control the pilot motor field, which rotates the rheostat in one direction, and T 3 and T 4 control the field which rotates the rheostat in the other direction. The grid circuits in this case are not shown in detail, but they are controlled either by the manometer contacts D or by the hand control switch C, either of which can be put into action by means of a change-over switch. When these contacts are open the thyratrons are non-conducting and the rheostat is at rest. The manometer has two sets of contacts arranged so that for small changes in air pressure the rheostat motor runs at normal speed, while for larger changes the speed of the pilot motor is increased, but only the slower rate of control is effective when the hand control switch C is used. The grid control consists of a bridge circuit which controls the phase of the grid voltage, and thereby the magnitude of the D.C. output. The eight thyratrons are mounted in one pillar, as shown in Fig. 35.

To shut down the fan motor, "Stop" push buttons are provided. If the button is depressed and immediately released, the motor is disconnected and coasts to rest, but if the button is held down for a second or two a dynamic braking resistance R 2 is put in circuit under the control of contactors 9 and 10, which rapidly brings the motor to rest. In either case, when the line contactor 7 opens, the coarse rheostat is automatically returned to the full-voltage position ready for the next starting operation.

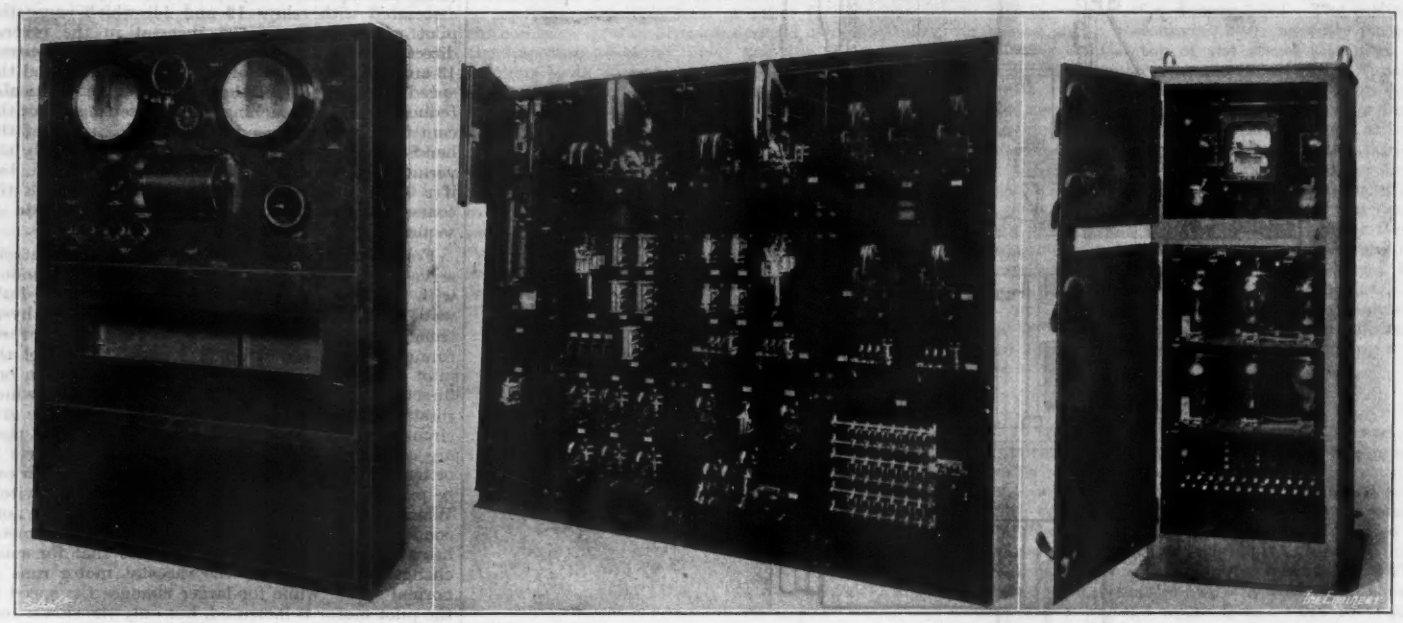
All the above-described controls can be initiated from either of the two control panels on the orifice wall. Each of these panels is fitted with a control switch by means of which the control can be trans-

ferred from one panel to the other. From both panels the operator can start or stop the motor generator set, start or stop the fan motor, and raise or lower its speed by means of the hand wheel controlling the "coarse" rheostat, and when the required wind velocity is obtained he can throw the control over to the manometer to maintain that velocity. The panels also carry the indicators A and B, indicating lamps, and other instruments by which the operator is informed of the exact conditions under which the equipment is working.

Power is fed to the equipment through switchboards carrying circuit breakers, isolating switches and instruments. The circuit breakers are interlocked to make it impossible for the negative breaker to be out while the positive line is alive.

The Manometer Control.

The manometer by means of which the speed of the air current is automatically controlled to remain constant, or substantially so, at any selected value, consists of a balance, Fig. 36, which weighs the air pressure existing in the return circuit of the tunnel against a weight. Variation in the speed of the air effects a corresponding change in the pressure and disturbs the balance and thereby, through a system of pneumatic relays connected to a series of electrical contacts, results in the actuation of the fine rheostat control of the fan motor in the manner described above. In addition, a system of coloured light signals is illuminated and shows at a glance the extent to which the wind speed has departed from the selected value. In operation two central, or white, lights are generally to be seen illuminated alternately, indicating that the wind speed is within $\pm\frac{1}{4}$ per cent. of the selected value. Occasionally the illumination may pass on to the adjacent green lights an indication that momentarily the wind speed has departed to the extent of $\pm\frac{1}{2}$ to $\frac{3}{4}$ per cent. from the selected value. If the extreme, or orange lights, are illuminated a departure of ± 2 per cent. or over is indicated. The actuation of the fine control of the fan motor automatically corrects the departure.

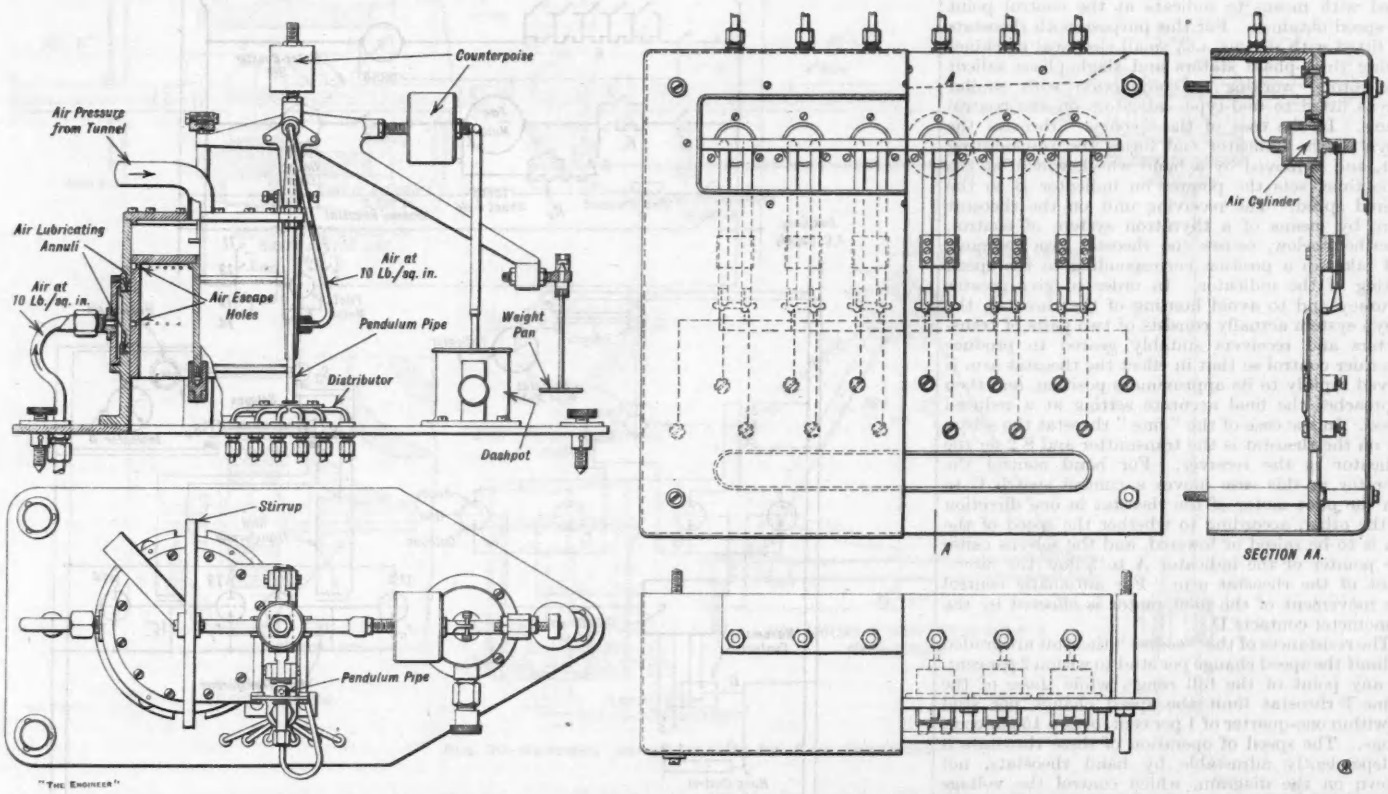


FIGS. 33, 34 AND 35—MASTER CONTROL STATION, MAIN CONTACTOR PANEL AND THYRATRON CONTROL PILLAR

The air pressure from the tunnel is admitted to the top of a cylinder, the piston of which is suspended by means of a stirrup from a beam mounted on self-aligning knife edges. At its other end this beam is coupled to a variable damping device, consisting of an oil dashpot, and carries a counterpoise and a weight pan. On this pan weights are placed in accordance with the selected velocity of the wind. So long as that velocity persists the beam will remain horizontal and the electrical contacts governing the fine control of the fan motor will remain open.

Surrounding the cylinder there is a jacket to which an independent supply of air at a pressure of 10 lb. per square inch is admitted. This air serves a double purpose. In the first place it is admitted into two annuli formed in the bore of the cylinder and acts as a lubricant to the piston. This lubricating air is prevented from passing to any material extent upwards into the space above the piston by the provision of two rows of holes which allow it to escape freely into the interior of the piston, the foot of which is open to the atmosphere. Secondly on the side of the jacket remote from the compressed air inlet, a pipe is attached which conducts a portion of the air upwards and delivers it through an orifice in a horizontal jet coaxial with the knife edge of the beam. This jet is received within a nozzle at the end of a pendulum pipe fixed to the beam and extending downwards from the level of the knife edges towards the base of the apparatus. There is a small gap between the orifice through which the air is emitted and the nozzle in which it is received. The air passes across this gap and enters the pendulum pipe without applying any turning moment to the beam.

At its lower end the pendulum pipe discharges the air against a plate in which six small holes are drilled in a row. If the beam is horizontal the air is discharged midway between the third and fourth of these holes and enters neither, or both equally. A little deflection of the beam one way or the other will cause the air to enter either the third or fourth hole. Increased deflection will cause it to enter the second or fifth hole and still more deflection will result in its being delivered into the first or sixth hole. From each hole a separate pipe leads the air to one of six small cylinders—see Fig. 37—the piston of which when pushed outwards by the air closes two electrical



FIGS. 36 AND 37—THE MANOMETRIC BALANCE AND PNEUMATIC-ELECTRIC RELAY

contacts. One of these contacts governs the fine control of the fan motor; the other is in the associated signal lamp circuit. The arrangement is such that reliable electrical contacts can be obtained from minute pressure changes in the tunnel.

The apparatus, it should be noted, does not provide a means of selecting the air speed. Its function is to preserve the selected speed constant or substantially so. It will fulfil this function provided the weight pan is loaded to the extent required to balance the pressure corresponding to the selected air speed. If the air speed changes accidentally the pressure will change and the beam of the balance will assume an inclined position. Provided the inclination is not great the angular tilt of the beam will be proportional to the percentage change in the pressure whatever the pressure may be. It is easy to prove that this characteristic of the apparatus is dependent upon the fact that the weight pan is attached to the beam at a point some distance below the knife edge axis. The air pressure being proportional to the square of the velocity, the percentage change in the air pressure will be equal to twice the percentage change in the velocity. It therefore follows that at high, intermediate or low air speeds the whole arrangement, including the signal lights, will react similarly to similar percentage changes in the air speed.

The manometer balance and its electrical connections were designed and made at the Royal Aircraft Establishment.

Conclusion.

In the compilation of this description of the new tunnel at Farnborough we have received generous assistance from a number of Air Ministry officers, notably from Mr. A. H. Hall, the Chief Superintendent of the Royal Aircraft Establishment, and his assistant, Dr. G. P. Douglas, and from Major D. Goad and Mr. A. R. Gibbs, of the Works and Buildings Department of the Air Ministry. We have also gratefully to acknowledge the help received from the principal contractors namely Boulton and Paul, Ltd., of Norwich, Sir Howard Grubb and Parsons, Ltd., of Newcastle, Clarke, Chapman and Co., Ltd., of Gateshead and the British Thomson-Houston Company, Ltd., of Rugby. The share taken in the execution of the work by these firms has been indicated in the course of our articles. In addition a number of other firms were entrusted with portions of the work as mentioned in the following list of contractors. For the illustrations accompanying our description we are indebted to the principal contractors, to the Royal Aircraft Establishment and to the Air Ministry. Certain of the originals used are Royal Air Force photographs of which the Crown copyright is reserved.

The Royal Aircraft Establishment laid down the aerodynamic requirements and designed the profile of the inner surface of the tunnel, the straighteners and the deflectors and was responsible for the specification and supervision of the construction of the main aerodynamic balance. The Directorate of Works and Buildings at the Air Ministry was otherwise responsible for the design of the structure and of the mechanical and electrical equipment and for the supervision of the various contracts connected therewith.

CONTRACTORS.

Building.

Main contractors: Boulton and Paul, Ltd., Norwich.
Sub-contractors to Boulton and Paul, Ltd.:
Reinforced concrete work: K. Holst and Co., Westminster.
Expanded metal, false walls and ceilings: The Self-Sentering Expanded Metal Co., Ltd., London.
Roofing to aeroplane shed: Ruberoid Company, Ltd., London.
Protected metal sheeting to upper structure, &c.:* Cellactite and British Uralite, Ltd., London.
Asphalte work: General Asphalte Company.
Folding doors to aeroplane shed: J. E. Lucas and Son.

Mechanical and Electrical Services.

Main 2000 h.p. motor, shafting and other electrical work: British Thomson-Houston Company, Ltd., Rugby.
Model lift equipment and balance cars: Clarke, Chapman and Co., Ltd., Gateshead.
Main aerodynamic balance and associated equipment: Sir Howard Grubb, Parsons and Co., Newcastle.
Passenger lift: J. and E. Hall, Ltd., Dartford.
Ventilating plant: James Keith and Blackman, Ltd.
40ft. jib cranes: The Vaughan Crane Company, Ltd.
Travelling cranes: Herbert Morris, Ltd.
Heating and hot water services: The Brightside Foundry and Engineering Company, Ltd.
Underground cables: Edison and Swan, Ltd.

* In order to correct a mis-statement in our issue of April 12th we take this opportunity of saying that while the roof of the aeroplane shed is of the Ruberoid Company's steel deck pattern, the roof of the main building together with the vertical walls of the superstructure and the gable ends of the aeroplane shed are covered with "Cellactite."

Engineers' Study Group on Economics.

At a meeting held by the British Science Guild in association with the Engineers' Study Group on Economics in the Lecture Theatre at the Institution of Civil Engineers, London, on Thursday, May 16th, 1935, at 5.30 p.m., a report was submitted for discussion. This report, after detailing the genesis and aim of the Group, opens with a commentary on the various schemes of economic reform which are before the world, and then gives, in appendices, a brief summary of each of the schemes. In view of the interest which our readers are showing in Douglas Social Credit and other reforms we reprint the commentary referred to above, premising it with a few words about the origin of the Group.

Genesis and Aims of the Group.

The economic events of the last few years have produced many remarkable results, but none more so than the general ferment of thought on the basis of the present economic structure. One result of this ferment has been that a little over a year ago a few engineers and scientific workers formed the Engineers' Study Group on Economics to examine the problems involved. In the following resolution, unanimously adopted at an early meeting, the Group defined their starting point:—

> "We, as a representative group of engineers and scientific workers, are dissatisfied with the fact that the community is not enjoying a standard of living and endowed leisure commensurate with the potential advance for which science and technology are responsible, and are meeting to discuss why the paradox arises and how it can be resolved."

The Group were well aware that the existence of this paradox, denied in some quarters and affirmed in others, had already attracted a good deal of attention and research; and they have therefore begun by dividing themselves into two main sections, one of which (A) is endeavouring to assess present and potential production, while the other (B) is examining various proposals which have been put forward for dealing with the situation.

First Interim Report of Section B.

Section B has now completed a preliminary examination of twenty-four separate sets of proposals, and summaries of each are set out in Appendix B.

Group I.—Monetary and Industrial Planning.

The schemes may be grouped first under three headings, according to the nature of the proposals.

(1) Monetary.	(2) Industrial Planning.	(3) Industrial planning and monetary.
Blackett	Macmillan	Bellamy
Consumer Money League	New Deal (U.S.A.)	Communism
Deane Plan*	Political and Economic Planning	Conservative Party
Douglas		Fascism
Gesell		Jevons
Kearney		Labour Party (Socialism)
Keynes		Liberal Party
London Chamber of Commerce		New Britain
McGregor		Socialist League
Melchett		Technocracy (Continental Committee)
Soddy		

* (The Deane Plan is difficult to place. It does not propose planning, nor yet is it a monetary proposal in the sense of the other systems classified under that head. It really suggests unemployment insurance of a special kind.)

Note.—The proposals included under Industrial Planning are those which lay special emphasis on the planning of industry. Each of the three has something to say on the monetary side, but the planning aspect is dominant. Each might be classed under (3). In the third group, the Conservative Party proposals have been included because of the planning activities now being carried out, viz., Marketing Boards and quotas.

The real division of opinion which this first classification is intended to emphasise is that existing between those who think that prosperity can be reached by alterations, radical or otherwise, in the monetary system; and those who believe that some control of industrial production is required. This may be complete or partial, and independent of or combined with monetary reform.

Immediate Practicability.—This division between monetary and other proposals is of importance in respect of immediate practical possibilities. Almost the whole of the proposals in the monetary group could be introduced, if wanted, to-morrow. Few, if any, of them would require elaborate preliminaries, and most of them could be brought into full operation in a comparatively short time. It is otherwise with the schemes into which the planning element enters; these would almost invariably take time to put into practice.

Another factor which goes far to determine immediate practicability is whether a particular scheme can be introduced by a single nation, or whether it requires a measure of international assent. Only three of the proposals fall within the latter category, those of Mr. Keynes, the Liberal Party, and the London Chamber of Commerce, and in each case only part—though a material part—of the full scheme requires international agreement. The obvious difficulties of obtaining such agreement on economic or any other action to-day suggest that from the standpoint of immediate practicability, these schemes should only be considered in respect of their national scope. Their full implications must not, however, be overlooked.

Group II.—Diagnosis and Cures.

Most of those who make proposals for economic betterment start with an analysis of the present situation, and there is a considerable difference of opinion as to the main causes of the existing position. There is also, however, what is perhaps more important, a measure of agreement among certain groups of schemes. The following monetary schemes definitely assert that there is insufficient purchasing power being distributed to purchase the goods which are being produced:—

Consumer Money League.	Keynes.
Douglas.	London Chamber of Commerce.

The Consumer Money League and Douglas proposals state that this deficiency is automatic and inevitable, and, accordingly, the Consumer Money League propose local note issues, while the Douglas proposals suggest remedying the deficiency either by issuing credit to retailers conditionally on sales at regulated prices, and/or by way of a National Dividend to every individual. To Mr. J. M. Keynes, the deficiency is not necessarily permanent, and his immediate remedy for the present situation is large-scale public works, financed by Government loans. The London Chamber of Commerce scheme proposes the monetisation of commodities by issuing currency against eligible trade bills.

Continuing our consideration of the monetary schemes, we find that the Gesell and Kearney schemes also assert that there is insufficient purchasing power; but their main remedy is designed to correct this shortage by increasing the velocity of circulation rather than the amount of money, although certain of their proposals would also have this latter effect.

Two more schemes, Melchett and Soddy, diagnose a shortage of effective purchasing power, but do so somewhat less definitely than those already mentioned. Lord Melchett proposes to meet the apparent shortage by monetisation of commodities and by paying off the National Debt by bank drafts. Professor Soddy holds that there is a shortage due to the fact that it is to the interest of the bankers who control the issue of money to keep it scarce, and proposes to nationalise the issue of currency and credit, and to govern such issue by a scientifically determined price index.

The three remaining monetary schemes, McGregor, Deane, and Blackett, stress lack of balance as mainly responsible for the present situation. The McGregor plan defines balance as balance between spending and saving. The existing situation is held to be due to over-saving, and can be rectified by raising or lowering the general salary and wage level by carefully calculated percentages. The Deane plan stresses maldistribution of purchasing power as a consequence of technological unemployment, and accordingly proposes a special kind of unemployment insurance. (This plan is American and does not appear to contemplate circumstances in which unemployment insurance, albeit of another kind, already exists.) For Sir Basil Blackett, the lack of balance is more general, and requires to be remedied by a currency based on a price index and managed with a view to maintaining stable prices. Planning and co-ordination are also generally commended.

This brings us to the next group of schemes, which arraign unco-ordinated individualism as largely responsible for the present troubles. This group falls into two sections:—

(*a*) Fascism, Macmillan, New Britain, New Deal (U.S.A.), and Political and Economic Planning.
(*b*) Bellamy, Communism, Jevons, Labour Party, Socialist League, and Technocracy (Continental Committee).

Each of the schemes in section (*a*) proposes a planned and co-ordinated economic system, and all except New Britain are confident that this can be done on the basis of private enterprise.

Planning and co-ordination are also part of the Conservative and Liberal proposals, but for these two the root of our trouble is found more in the international sphere. The Liberal Party's main solution, as has been already pointed out, is international also, but both the Liberals and the Conservatives recognise that the international situation is not capable of direct control, and planning to some degree becomes the necessary national policy.

The six schemes in section (*b*), while stressing the failings of unco-ordinated individualism, are sharply distinguished from those in section (*a*) by their emphasis of the "profit-motive" and private ownership of the means of production as the root causes of our present economic troubles. These schemes regard a shortage and/or maldistribution of purchasing power as inevitable so long as the means of production are privately owned and the profit-motive continues to operate. They therefore propose ownership and control, if not operation, of all production by the community.

Group III.—Radicalism.

In this grouping an endeavour has been made to take into account ultimate sociological effect, as well as immediate economic expedients, and the classification is broadly based on consideration of the general characteristics of each scheme, including the extent of the changes envisaged in administrative application, alterations in the economic structure, and the final sociological effects. The result is as follows:—

Extent of change.	Group.	Schemes.
Minimum.		
Relatively minor changes in existing system.	I.	Blackett, Conservative, Deane, Keynes, Liberal, London Chamber of Commerce, McGregor, Melchett.
Greater changes in existing system.	II.	Fascist,* Macmillan, New Deal (U.S.A.), Political and Economic Planning. (*Fascism has certain aspects which would place it in Group V.)
Fundamental changes of minor order.	III.	Consumers' Money League, Douglas, Gesell, Soddy.
Greater fundamental changes.	IV.	Kearney, New Britain.
Complete re-orientation of economic and social order.	V.	Bellamy, Communism, Jevons, Labour Party, Socialist League, Technocracy (Continental Committee).
Maximum.		

Group I do not wish to alter anything fundamental. The adjustments they propose are comparatively speaking minor. The bulk of the monetary schemes come under this head, along with the two older political parties.

Group II go somewhat farther, though the difference between the most radical of the first group and the least radical of the second is not great. This group is distinguished by the fact that two of the four schemes are in practical operation in other countries.

Group III includes the more radical monetary schemes, which would alter fundamentally the existing financial arrangements. It might be argued that this is not true of the Douglas scheme, but the conception of a National Dividend issued to every individual is something quite

outside the existing system.* The same applies to Silvio Gesell's "Demurrage Money." Superficially, such a proposal may appear to suggest a modification comparatively slight in our existing arrangements; in fact, as the demurrage money involves the elimination of interest, the difference is fundamental.

The two schemes in Group IV go still farther. New Britain would extend planning considerably beyond the limits contemplated by the schemes in Group II, while the Kearney plan is a development of the Gesell scheme without Gesell's deep-rooted opposition to the State doing anything which could possibly be done by private individuals.

Finally, in Group V are schemes which make the question of private profit a major issue. The Labour Party and Socialist League proposals, which differ only in tempo and degree, tend strongly towards the elimination of private profit. The remaining four, Bellamy, Communism, Jevons, and Technocracy, definitely propose to abolish it. The proposals of the Continental Committee on Technocracy may be regarded as a modern development of Bellamy's ideas, while Professor Jevons' proposals are not dissimilar. Communism differs from the rest of the group principally in its psychological approach.

Two Further Criteria.

Two further criteria, the emphasis of employment (as distinct from endowed leisure), and the attitude to economic liberty, have been applied with the following results.

(1) *Employment or Endowed Leisure.*—There is a clear-cut distinction between schemes that stress employment, and insist that all men must as far as possible work for their living, and those that consider increasing mechanisation likely to make that impracticable. The latter propose some distribution of purchasing power to each individual as a human being or citizen independently of the work he does.

On this point it is noteworthy that every scheme accepts without serious question such channels for the distribution of purchasing power alternative to earning as now exist in this country; for example, Old Age Pensions and Unemployment Insurance. Some of the schemes propose to add to or deepen these channels. Moreover, the Poor Law embodies the principle that no individual should (theoretically) be allowed to starve. But there is a fundamental division between the schemes that retain as basic motives the fear of want and the desire for wealth, and those that do not. The latter, which lay down the principle that every individual shall be given economic security in the form of at least a reasonable minimum standard of living—either as a natural right without corresponding obligation to work, or in return for services of one kind or another required of them by the State—are :—

Bellamy, Communism, Douglas, Jevons, Kearney, New Britain, and Technocracy.

The Socialist League is a potential addition to this group, but the Labour Party with its emphasis on work rather than maintenance must be classed here with the more conservative majority.

(2) *Economic Liberty.*—This criterion must be applied with care. The phrase "Economic Liberty" as commonly used means liberty to maximise personal gains by any means within the law. Those who use the phrase in this sense generally hold that such liberty is essential to encourage individual initiative and increase national wealth and efficiency. The schemes that attach importance to economic liberty of this kind are :—

Blackett, Conservative, Deane, Keynes, Liberal, London Chamber of Commerce, McGregor, and Melchett.

A second group of schemes also regard liberty to acquire wealth as important, but consider that restrictions on individuals in their pursuit of wealth are necessary to a greater extent than exist to-day. These are :—

Fascism, Macmillan, New Deal (U.S.A.), and Political and Economic Planning.

A third group, while deeply concerned to minimise all restrictions on individuals, extend the conception of Economic Liberty. For them, economic liberty, while including liberty to acquire wealth, must be enjoyed by all, and may consequently be granted to any one individual only to the extent that it does not thereby encroach on the liberty of other individuals. This group includes :—

Consumers' Money League, Douglas, Gesell, New Britain, and Soddy.

The Kearney scheme envisages, as necessary to universalise liberty, rather greater restrictions on the means by which the individual may acquire wealth. Finally, there is a fourth group of proposals which regard liberty to make private gains as largely, if not wholly incompatible with economic liberty for all. In this fourth group we have :—

Bellamy, Communism, Jevons, Labour Party, Socialist League, and Technocracy (Continental Committee).

The Question of War.—There is one factor of special importance in relation to any economic system—the question of war. Most of the schemes in the last two groups just referred to, while admitting that war springs from many causes, argue that the dominant cause is economic, and that the present economic system tends strongly to lead to armed conflict. At the same time they claim that any system, and in particular their own proposals, which give economic security to all would go far to eliminate the danger of war.

Poverty and Plenty.

With the exception of a few of the least radical, every scheme stresses the point that there is potential plenty for all. Yet it is a striking fact that some professional economists contest this statement. It is possible that the difference of opinion on this fundamental point is due to a misconception. Poverty to-day is evident on every hand. Mr. Colin Clark* has calculated that the equal distribution of the national income in 1931, not including income from overseas, and maintaining the existing rate of investment, would give an average family income of some £270 per annum to all, including the unemployed. This is clearly not plenty, though it might seem like it to the millions whose incomes are at present below £150 per annum.

The point is—and few would dispute it—that the present real national income in goods and services is much less than it might be. On the one hand, there is a considerable amount of communal waste. Between 1923 and 1934 the number of people employed in the distributive trades (*e.g.*, shopkeeping) increased by 55 per cent., or 600,000. In June, 1934, the total number employed in distribution exceeded the combined totals of workers in the coal mining, general engineering, cotton, woollen, iron and steel, and shipbuilding industries. Such figures suggest that distribution as at present organised involves a large-scale waste of effort. Other forms of communal waste may be found in the extent and complication of the financial side of industry.

On the other hand, few industries are working at full pressure. Deliberate restriction of production is widespread and has Governmental sanction in most countries. There has even been deliberate destruction of goods produced, particularly in the U.S.A. and in Brazil. In this country fruit has been left to rot and fish thrown back into the sea. Schemes to restrict agricultural production have been adopted, and plant for producing ships and textiles has been deliberately destroyed. The restriction of imports and encouragement of exports in the face of tariffs and exchange restrictions which frequently make the securing of payment extremely difficult—these also tend to reduce the real national income in goods and services.

Even if, however, we disregard for the moment the rest of the world as a factor which we in this country cannot control, it is a fact that in Great Britain to-day there are :

(*a*) Large numbers of men and women unemployed;
(*b*) Large sums of money lying idle (this may or may not be regarded as important);
(*c*) Many urgent jobs waiting to be done;
(*d*) Manufacturing and power producing plant standing idle.

The numbers of unemployed are painfully familiar; the money waiting employment is indicated by the repeated over-subscription of new issues; and, as for urgent jobs, there is housing, in many large cities a shame to modern civilisation; there is water supply—the discomforts of a fine summer have been widely felt; and—to mention only one more—there is suburban railway electrification. Ordinary common sense tells us that the situation is ridiculous, and if we only cling fast to the fact that the economic system was made for and by man, and not man for the system, no amount of learned reasoning will shake that conviction. It is, indeed, ridiculous and something has got to be done about it.

What is that something?

As yet the Engineers' Study Group does not profess to know. The only people who do profess to know are to be found among the convinced supporters of particular sets of proposals. Appendix B records twenty-four of these. Their diversity has been indicated. They cannot all be right.

Yet neither can the problem be insoluble. Many of the disputed points appear to be questions of fact. Common sense and scientific examination can be applied to all of them.

The Group's Starting Point.

This, then, is the starting point of the Engineers' Study Group. And, as befits engineers, they have begun by asking what should be the function of this economic machine whose workings they are trying to probe. No sane engineer starts to design a lay-out until he knows what the plant is required to produce. The question of means does not logically arise until the question of ends is settled. And on ultimate ends there is a measure of general agreement which contrasts strongly with the controversy which rages round the question of means.

Put briefly, the Group seeks economic arrangements which will :—

(1) Abolish poverty.
(2) Lighten labour.
(3) Increase leisure.
(4) Deepen and widen liberty.
(5) Minimise friction.

The last of these is a transitional requirement; the other four are fundamentals, and as such they merit careful consideration.

The first aim, abolishing poverty, has not hitherto been found practicable. Leisure and comfort for a select minority in order that they might extend culture and knowledge and conduct the business of government has always had to be balanced by poverty for the majority. But that poverty does not appear to have previously coincided with the large-scale destruction of material wealth. Common sense suggests that if to-day food and raw material can be destroyed in immense quantities owing to the lack of effective (but not lack of real) demand, the necessity for continued poverty is rapidly passing, if indeed it has not already vanished. Such a suggestion is strongly reinforced by the present prevalence of unemployment among the factors of production. This first aim seems therefore practicable, and few will argue that it is not also desirable.

The second aim, lightening labour, distinguishes the Group at once from those depressed humanitarians who want to stop all mechanisation. As engineers, the Group naturally see in mechanisation the release of man from drudgery, and they look to developing mechanisation to lighten human labour much more than it has yet done.

The same applies to the third aim, increasing leisure. Mechanisation has shortened working hours. If applied with greater efficiency and coupled with elimination of waste, it would shorten them very much more. But leisure requires to be properly distributed and reasonably endowed. To-day, enforced leisure in the form of unemployment is a contingency rightly dreaded. For most people it means poverty and loss of self respect. Without employment a man is apt to feel useless and unwanted. Leisure can only be enjoyed by those who possess sufficient means and sufficient education to make good use of it. Accordingly, this aim of increasing leisure must be taken in close conjunction with the first aim, abolishing poverty, and with its implied corollary, improving education.

The fourth and last aim, to deepen and widen liberty, requires very careful definition. Liberty here is defined as freedom to follow one's own desires as far as is possible without overriding the desires of other individuals. If the freedom of the strong interferes with the freedom of the weak, there is a case for restriction. There is equally a case if the freedom of the rich interferes with the freedom of the poor. For the academic economists the final aim of our economic arrangements appears to be to give the consumer the fullest freedom of choice as to what he consumes. They reject "planning" on the ground that it would restrict that freedom of choice to the goods that were in fact produced. That does not seem an impressive argument. The freedom of the consumer is to-day restricted by the amount of money he possesses, and if he is poor or unemployed, the restriction is grave indeed. Any assumption, therefore, that so far as liberty is concerned it is only a question of retaining an existing and sufficient freedom appears to be false. The existing liberties of many citizens are capable of being greatly deepened and widened by methods which may include increased restrictions on those whose interests do not happen to coincide with those of the majority of their fellows. The apparent paradox is only apparent and is at once easily resolved by the application of the definition of liberty given above.

This then is the Group's agreed objective, and it at once provides a touchstone for application to the welter of varied proposals which they have been and are examining. The economists who have sedulously disclaimed any definite objective, and have proclaimed economics as a pure science would appear thereby to have placed themselves under a severe handicap from the point of view of contributing to real human progress. Political economy may utilise mathematics but if it stops there it disregards the fundamental economic factor, man.

The Engineers' Group believe that in starting with the aims defined above they have put that fundamental factor back in its rightful place, and that only when that has been done does the problem become soluble.

The Group have thus completed the first stage of their investigations. They have (1) set out broadly the main functions that the economic system should fulfil; (2) examined twenty-four sets of proposals for modifying the existing system. The next step will be to correlate the results obtained and decide :—

(*a*) Which schemes have aims coinciding with those indicated above;
(*b*) Whether such schemes are individually practicable;
(*c*) Whether, having regard to the facts of the present situation, effective advance in the direction of the aims agreed demands some combination of the proposals put forward by various schemes rather than the simple application of any one of them.

Investigations along these lines are being pressed forward. The need for an agreed solution is urgent. The work involved in reaching one is considerable. Technical progress should be a universal blessing. From all who accept this view the Engineers' Study Group will welcome co-operation.

* The correct placing of the Douglas scheme in the above grouping depends on how the alleged deficiency of purchasing power is made up to the public. If this is through price reductions, the change is less than if part or the whole is distributed as a uniform dividend to all individuals. From the former standpoint, the scheme would fall in Group I; from the latter, Group III.

* "The National Income, 1924 to 1931," by Colin Clark (Macmillan).

"COUNTRY LIFE"—A 2000th NUMBER.

Many of our readers who from scientific or manufacturing activities turn readily to country interests will, we are sure, join with us in congratulating our contemporary *Country Life* on its 2000th issue. It was founded in January 1897 by Mr. Edward Hudson, who has presided over its destiny and directed its policy and activities, and with his staff has made it an indispensable journal to all who are interested in country life and country pursuits. One of its real accomplishments has been the description in minute detail of over twelve thousand English homes and gardens. By its interest in architecture old and new, and in the design of smaller cottages and houses, *Country Life* has by its articles and the books it has published exercised a lasting influence on the right kind of housing activity and the development of applications of industrial art. It has not neglected the many benefits which have been conferred by the engineer on country life, and in its pages there have been recorded the great improvements which in close upon half a century have taken place alike in electric lighting, pumping, and other branches of domestic engineering. On the side of transport it has faithfully marked the continued improvement of the motor car from the cars described in its first issues, some of which we note would reach 25 miles per hour, if desired, to the modern high-speed cars and aeroplanes which find an appropriate place in its 2000th birthday issue. All this has been done with a standard of writing and photographic illustration which are out of the common, even for weekly publications.

A new method of jointing aluminium alloys without the danger of injury to the metal involved in welding processes, is announced in *Flight*. The material used in the process is known as "Alusol," and will, it is said, join aluminium in cast, rolled, sheet, or tube form, Hiduminium, Duralumin, or Birmabright, with a strength equal to that of the unjointed material. It is claimed that "Alusol" withstands corrosion as the result of a process used in its manufacture, and is not affected by ageing. The method of using the material is quite simple and is analogous to soldering, except that no flux of any kind is required. It is understood also that an aluminium tube can be fastened into a steel bracket by this process, if the steel bracket surface is first tinned with soft solder and that such a joint will stand a pull of approximately 6 tons per square inch.

Rail and Road.

FROM a paper on "Street Traffic Signals" by Mr. F. Edwards, read before the Institution of Railway Signal Engineers on May 8th, it appears that at the end of last February grants had been made by the Ministry of Transport for the erection of signals at 1706 street crossings in England, Wales, and Scotland, and that since the trial set of the vehicle-actuated method was installed in the City of London in March, 1932, and the approval of that system by the Ministry of Transport in the following September, no less than 854 street intersections have been equipped with that type or have been sanctioned.

OWING to its weak and dangerous condition, Balderson's Bridge, over the Grand Union Canal between Apsley and Hemel Hempstead, Herts., is to be demolished. The Minister of Transport has approved the County Council's scheme for the building of a new bridge and approaches at a cost of £9500, towards which a grant has been made from the Road Fund. Balderson's Bridge is a hump-backed structure, 18ft. between parapets, with a load restriction of 5 tons. The new bridge, which will comprise steel deck troughing on concrete abutments, will be 42ft. wide and the approaches will be widened accordingly for 300 yards.

THERE was a slight collision between two passenger trains in Liverpool-street Station, L.N.E.R., on November 24th last, as to which Colonel Woodhouse has just reported. On the west side of the station is No. 1 platform; then, with Nos. 1 and 2 roads intervening, comes Nos. 2–3 platform; east of that, with Nos. 3 and 4 roads intervening, is Nos. 4–5 platform. At about 8.48 a.m. on the day in question, a train arrived off the up suburban line in No. 1 road. It did not, however, run the full length, but stopped with its rear portion foul. The points were then changed and the signal lowered for a train to leave No. 4 road for the down suburban, which would cross the path taken by the arriving train. As the tail of the latter was on a "clearance" bar, the signal should have been held, but, owing to the lock being worn, the trial by the signalman of the signal lever, to see if it were free, forced the lock out and the lever could be pulled.

THE contrast between the passenger-carrying vehicles of twenty-five year ago with those now to be found on the principal expresses of British railways, to which a note on our "Seven-Days' Journal" page of May 10th referred, reminds us that when Colonel Mount, of the Ministry of Transport, was discussing the Port Eglinton Junction collision of September 6th last, he said that both the trains concerned in that accident were largely composed of stock of an older type. The explanation offered for that fact was that it was evident that all vehicles cannot be of the same age and type of construction, nor equally suitable for all services, and that it was as essential to obtain the maximum economic use of each vehicle as of the locomotive which hauled them. Further, the policy of giving preference to the renewal of main line stock was adopted to a substantial extent, as the most efficient procedure, and it was impossible to avoid altogether the practice of transferring to less important services the main line stock displaced.

IT was announced recently that the Ministry of Transport had made an Order authorising the construction of extensions of the two sidings at the east—or terminal—end of the Liverpool Central Low Level Station of the Mersey Railway. The object of the work is to allow the trains, during the peak periods, to have six coaches instead of five. On arrival from Birkenhead most of the trains pass into the more southerly of the existing sidings in order to reverse and proceed to the other platform. The more northerly siding is used more for stabling purposes. Each siding is in a separate tunnel, and that holding the former siding is to be lengthened by 125ft. and the latter by 100ft. There is also to be a subway at the farther end for ventilation purposes and for inter-communication between the sidings when necessary. The platform is to be extended 60ft. The excavation in the tunnels will be in sandstone, and the whole work will cost £25,000. The contractors are Sir Robert McAlpine and Sons. What is of additional interest is that there is no necessity now for such works to require Parliamentary sanction. Under Section 16 of the Railways Act, 1921, the Minister of Transport could authorise railway companies to provide such minor alterations and extensions and improvement of works as will not involve an expenditure exceeding £100,000. By the Railways (Authorisation of Works) Act, 1923, that sum was increased to £500,000.

IT is twenty years since there occurred, on May 22nd, 1915, the worst railway accident on British railways. Up to that time the worst had been the failure of the Tay Bridge on December 28th, 1879, when sixty-eight passengers and five servants were drowned, and the Armagh disaster of June 12th, 1880, when eighty passengers, the majority of whom were school children, lost their lives. The accident now under notice was that at Quintinshill, which was caused through the signalman overlooking a down local passenger train that he had shunted on to the up line to allow one of the night Scottish expresses from Euston to pass it. Whilst the local train stood there, with its engine only 62 yards from the signal-box, an up special train from Larbert, conveying the 1/7th Royal Scots to Liverpool *en route* to Gallipoli, was accepted and the signals lowered for it. As a consequence of the resultant collision, the down line was obstructed by wreckage, into which the express from Euston ran. Fire caused by live coal from three engines broke out, and the total fatalities were two passengers in the local train, seven passengers and a sleeping car attendant in the express and, it was estimated, 165 passengers in the troop train, together with its driver and fireman. Three officers and forty-seven other ranks were reported as missing, and were presumed to have been lost in the fire. Some, however, that were reported missing had travelled by other trains and had sailed for Gallipoli. One of the remedies against such an accident was track circuiting, but the late Colonel Druitt said in his report to the Board of Trade that if track circuit had to be adopted universally, Quintinshill would be one of the last places to be dealt with as all the lines were in full view of the signalman.

Miscellanea.

MR. WILFRED COOK, Assistant Secretary to the Electricity Commissioners, retired on May 11th, 1935, under the age limit after fifteen years' service with the Electricity Commission. Mr. Cook has a record of forty-two years' public service in all, having served with the London County Council for twenty-seven years before transferring to the Electricity Commission on its establishment in 1920.

AT a recent meeting of the London County Council the Chairman of the Highways Committee said that the demolition of Waterloo Bridge was expected to be sufficiently advanced to enable work on the new bridge to be begun by about the middle of 1936. Precise dates, however, could not be given owing to the nature of the work, which called for safety as much as speed. The work was being carried out with little variation from the original calculations.

AT its recent annual meeting the Association of Supervising Electrical Engineers approved the necessary alterations to the rules to allow for the introduction of a new grade to be known as associate membership. The qualifications for associate membership are as follows:—"Applicants shall be engaged in the distribution, installation, utilisation, and/or selling of electricity and/or electrical apparatus, and whose experience and duties of employment involve technical and/or commercial duties."

CALCULATIONS made by the International Labour Office at Geneva on the basis of 1930 statistics indicate that "real wages" (purchasing power) in Canada are the second highest in the world. On the basis of wages in Great Britain reckoned at par (100), "real wages" in the United States are calculated at 190, as compared with 155 in Canada, the countries next on the list being Denmark, Sweden, Great Britain, the Irish Free State, then Netherlands, Germany, Poland, Austria, Jugoslavia, Spain and Italy.

ONE of the Magistrates' Courts at Rotherham has recently been equipped with loudspeaking apparatus which, it is said, is giving complete satisfaction to everyone concerned with the duties of the court, incidentally making the work much easier for all. The installation consists of a G.E.C. microphone mounted on the front of the witness box and is connected by special amplifier to a loud-speaker fitted below the desk of the Chief Magistrate. It renders the witnesses' evidence distinctly audible to the whole of the court.

IN a recent discussion at a meeting of the National Association of Colliery Managers, Mr. A. Dawe said that for the hydrogenation process alone, and not taking into consideration any other method for obtaining motor spirit from coal, it had been calculated that about 3½ tons of coal would be needed for the production of 1 ton of motor spirit. This meant that 10,000,000 tons of coal, or only about 5 per cent. of the saleable coal raised each year throughout Great Britain, would be sufficient to supply the country with motor spirit.

AN extract in *Mechanical Engineering* describes a means of inhibiting corrosion in boilers by means of chemical deaeration, using sodium sulphite. It says that a known amount of the material may be dissolved in a given amount of water and the solution fed periodically or continuously to the feed water after it has passed through the mechanical deaeration equipment. It may be fed into the water with other chemicals. Periodic dosing is satisfactory if economisers are not used. When economisers are used it is necessary to carry a constant feed of the sulphite solution to prevent corrosion within the economiser because of the liberation of oxygen when heat is applied. So far as the boiler itself is concerned, it may be protected against oxygen corrosion by the maintenance of sodium sulphite in the water.

THE Official Returns rendered to the Electricity Commissioners show that 1330 million units of electricity were generated by authorised undertakers in Great Britain during the month of April, 1935, as compared with the revised figure of 1188 million units in the corresponding month of 1934, representing an increase of 142 million units, or 11·9 per cent. The number of working days in the month, *i.e.*, excluding Sundays and Bank Holidays was twenty-four, the same as last year. During the first four months of 1935 up to the end of April, the total amount of electricity generated by authorised undertakers was 6029 million units, as compared with the revised figure of 5458 million units for the corresponding period of 1934, representing an increase of 571 million units, or 10·5 per cent.

IN a recent report on the explosion of a locomotive boiler the cause is stated to have been the corrosion of the middle section of the barrel plating at the bottom which caused the plate to become so thin that it was unable to withstand the pressure to which it was subjected. The boiler was thirty-five years old and had been regularly inspected and overhauled. Examination after the explosion showed that in places along the line of rupture the material had wasted to paper thickness, but the wasting had been confined to a great extent to one section of the boiler shell and to the plate in the vicinity of the rupture. The severe pitting and corrosion in the barrel are attributed to the fact that the middle ring of the barrel plating was fitted outside at one end and inside at the other, thus giving a run to the plate at the bottom which, when the boiler was empty, formed a lodgment for sludge or water at the front end of the plate and against the edge of the adjacent plate. Since 1927 the engine was used intermittently only, the periods during which it was lying idle were often of many months' duration, and it was customary to run the engine into the shed, draw the fire, and to run the water out of the boiler. Owing to the formation of the barrel, a residue of water and mud would be left lying at the front end of the middle ring on the bottom, and local corrosion resulted. In the observations of the Deputy Engineer Surveyor-in-Chief, it is stated that at some time previously an attempt had been made to cover a portion of the wasted plate by depositing welded metal on the surface. Such practice applied to the shell plate of a boiler is strongly deprecated, as being in itself a possible cause of local stress, cracking and failure.

Air and Water.

THE premier French Air race, the Coupe Deutsch de la Meurthe, was flown on May 19th, and won by Monsieur R. Delmotte, who covered the 1250 miles triangular course at an average speed of 276 miles an hour.

THE first of the fleet of seventeen sailing ships competing in this year's "race" of grain carriers from Australia reached Queenstown on Thursday, May 16th, having left Port Victoria on February 14th. She is the German four-masted barque "Priwall."

THE Air France Company has issued an official announcement stating that a new air line between London and Madrid has been started. The new service will be operated by Air France and the Spanish National Airways, and according to the schedule the 1000 miles between the two capitals will be covered in under six hours.

FOUR vessels of the Furness-Withy fleet are reported to have been purchased by T. and J. Harrison, of Liverpool, who trade between this country, South Africa, India, and South America. The vessels are the cargo liners "British Prince," 7939 tons; "Imperial Prince," 7896 tons; "Royal Prince," 7886 tons; and the "London Merchant," 7939 tons. The purchase price is reported to be £123,000.

A BILL by which the Port of London Authority seeks Parliamentary powers to spend more than £1,750,000 on a five-year scheme of docks improvement has been ordered by the House of Lords Committee on Unopposed Bills to be reported to the House for third reading. The scheme provides for the removal of jetties at the Royal Victoria Docks and the construction of 6000ft. of deep-water quayage.

A NEW class of Admiral's Barge is being supplied to the new Admiralty yacht "Enchantress." It is a 24ft. 6in. motor boat with a 100 h.p. petrol engine, capable of a speed of 30 miles an hour. The accommodation consists of a cockpit forward, a roomy cabin amidships, and a well, in the after part of which the engine, covered by flush hatches, is set. The saloon has two long settee berths, and is 5ft. 6in. high. Forward of the cockpit is a water-tight collision bulkhead.

A NEW Italian air route linking Rome with the Italian East African colonies is to be inaugurated. A provisional agreement, to last six months, has been signed by the Egyptian Government. The route, passing Tripoli, Benghazi, Tobruk, and Alexandria, will follow the Nile Valley as far as Khartoum, and then diverge east to Eritrea. From the Eritrean port of Massawa it will continue *viâ* Jibuti and Berbera to Mogadishu, the port of Italian Somaliland. The total distance of 5000 miles will be covered in four days.

A NEW and improved type of "Comet" twin-engined monoplane is being made by the de Havilland Aircraft Company for Mr. T. Campbell Black. The new "Comet" will be similar to the three which took part in the Australia race, but will incorporate a number of refinements and modifications. The engines will be the standard Gipsy Six 200 h.p. type, slightly altered to give an increased output, decreased fuel consumption, and reduced drag. High-octane fuel will be used and Ratier variable-pitch airscrews will be provided. The machine in its new form will cruise at 220 m.p.h. at 10,000ft., and will have a range of 2750 to 3000 miles.

THE new Thames motor vessel "Royal Princess," which has recently been commissioned for Thames service under the ownership of Captain A. Crouch, marks a further development in river transportation. She was built by the Rowhedge Ironworks Company, Ltd., of Rowhedge, near Colchester, and is propelled by a five-cylinder, 125 b.h.p. Crossley scavenge pump airless injection motor with oil engine-driven auxiliaries. The "Royal Princess" has an overall length of 114ft., and a length between perpendiculars of 109ft. The breadth over rubbers is 17·75ft., the moulded depth being 6ft. 6in., while 350 passengers, approximately, are carried on a load draught of 3ft. The engine-room is aft, giving space for a commodious dining saloon.

THE Bombay correspondent of the *Daily Telegraph* reports that a coast air mail from Bombay to Trivandrum is to be inaugurated shortly, and it is expected that the route will later be extended to Trichinopoli. An aerodrome is under construction at Colombo for the Madras-Colombo air service, which is expected to start before the end of this year. These plans form part of the Indian Government's £700,000 scheme to build up air communications throughout India. Other measures contemplated are the setting up of a national flying school, possibly at Bombay; the provision of hangars for large air liners at all important air ports, and a scheme for lighting the trans-India air route, thus speeding up the Australian air mail service.

IN the course of a speech made at the annual meeting of the Federation of Engineering and Shipbuilding Trades at Hastings, on Monday last, Mr. W. Westwood, of Newcastle, the President of the Federation, stated that more than half the workers in the shipbuilding industry had left it since 1921, and of those remaining 46 per cent. were unemployed. He was confident, however, that the near future would show an improvement that would give them encouragement and satisfaction. The increase in the tonnage of merchant vessels under construction was being maintained, he said, and the industry was showing renewed activity. More than 600,000 tons of British shipping were now under construction, including 144,000 tons representing new merchant ships laid down in the shipyards during the past three months. This was a slight increase over the previous quarter, and represented the confidence in the growing improvement in world trade. Dealing with the engineering industry, Mr. Westwood said the unemployment figure at the end of last year was 12·6 per cent., compared with 16·3 per cent. a year ago. There was a general improvement during the year, a satisfactory feature being an improvement in the export trade. Reorganisation and extension schemes for several large firms were in progress, and in some departments demand was running ahead of productive capacity.

THE ALBERT CANAL, BELGIUM—CASTER AND EYGENBILSEN CUTTINGS

(For description see page 530.)

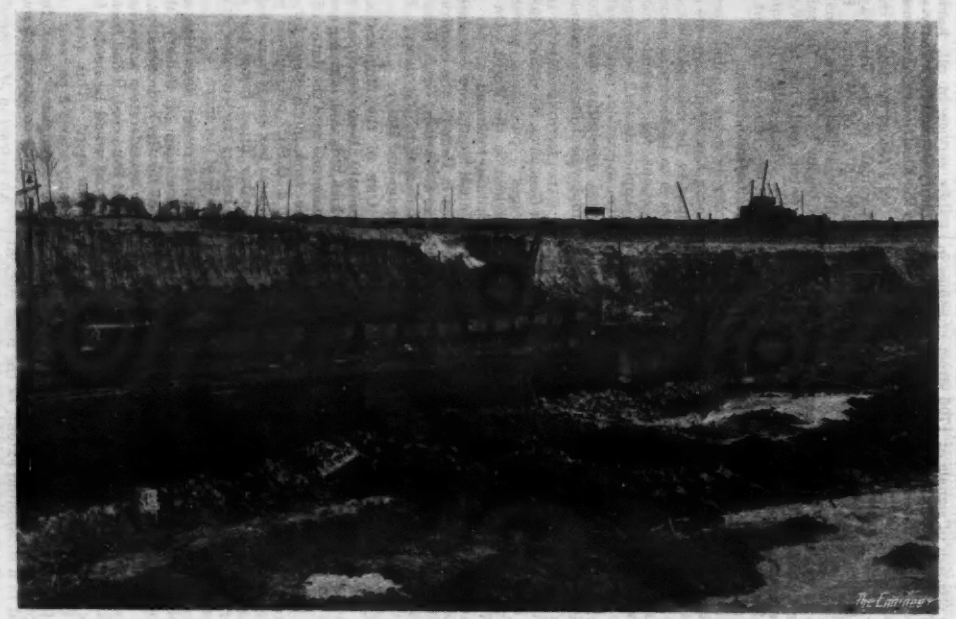


FIG. 24 (ABOVE):—SOUTHERN END OF CASTER CUTTING—JUNE, 1934

FIG. 25 (BELOW):—EYGENBILSEN CUTTING—TRENCHING FOR SIDE DRAINS—APRIL, 1934

FIG. 26 (ABOVE):—NORTHERN END OF CASTER CUTTING—APRIL, 1934

FIG. 27 (BELOW):—EXCAVATION IN EYGENBILSEN CUTTING—APRIL, 1934

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**** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

THE PARIS FAIR.

THE character and importance of the engineering participation in the annual Paris Fairs are modified by industrial tendencies, economic developments, and the possibilities offered for business at times when foreign manufacturers are debarred by import restrictions from exhibiting goods which they cannot freely sell. These gatherings, therefore, reflect the commercial aspect of engineering at the moment. More than in previous years the Fair now being held in Paris conveys an impression of changed conditions in the French market for engineering products and of tendencies that may produce greater changes in the future. As a manifestation of the wide range of French industrial resources, the Fair is remarkably interesting and instructive, and in these times of industrial depression it reveals a vitality which should respond readily to any signs of recovery. An evolution is in progress which, if carried out according to plan, will inevitably effect a change in commercial relations with other countries. Some idea of the nature of this development may be gained in the Machinery Hall, where the abstention of French and foreign machine tool makers, probably for commercial reasons, is observable. An absence of buying is a valid excuse for economy. There is, nevertheless, evidence of a new departure in the production of precision machines of all kinds, which is a logical consequence of the desire of French manufacturers to produce everything that may be required for their own market. Another instance of progress is observable in the printing machine section, where the fewness of foreign exhibits gives more prominence to the French industry, which is largely specialised in Paris, Lille, and the Lyons suburb of Villeurbanne. The development of machine construction made evident by such exhibits is being carried on methodically during a time of depression and at a time when manufacturers can have little hope of securing immediate profit from their enterprise. An unusual feature of the Machinery Hall is that one half of the vast building is occupied by heating appliances, the making of which provides much-desired work for ironfounders and metal workers.

Encouraged by the demand for public works machinery under the programme of relief undertakings, the construction of mechanical shovels, road rollers, concrete plant, and other machines has become the most active branch of the French engineering industry. Until a few years ago the considerable space allotted to public works machinery was largely occupied by German, American, and British firms, but the situation this year is reversed, doubtless through the restrictions imposed on machinery imports, and the exclusion of foreign machinery from works carried out under the relief programme. That exclusion does not appear to be absolute, for mechanical excavators of British and American make are very generally employed, and they are well represented at the Paris Fair. But the potentialities of French competition are evidenced by the growing importance of home exhibits. As in other branches of industry, makers are grouped into an influential association, which is an organising body that keeps its members informed on technical progress and aims at securing preference for French machinery and plant. Aided by this encouragement, makers who had specialised in the lighter descriptions of machinery are now exhibiting excavators and road rollers for all purposes, and one French firm shows departures from ordinary design by actuating excavator buckets by toothed sectors and pinions, and presenting a machine with a bucket sliding on a horizontal jib near the ground for shovelling soil back into the trench. A comparison between the work done by a French excavator and a neighbouring American machine, lighter, handier, and more compact, was instructive. The construction of efficient public works machinery is based upon long experience. The fact remains that French manufacturers have made great efforts during the past few years to put themselves in the front rank as suppliers of such machinery, and their competition will have to be taken into account, at least for some products. In excavators they lag behind foreign makers whose machines have won a reputation for efficiency by long years of practical work in France. Public works contractors do not allow national sentiment to stand in the way of the economical and efficient execution of their tasks.

This bringing of machinery production into the general scheme of national self-sufficiency adds to problems that may complicate international exchanges. French makers claim that all State orders for machinery should be reserved for the national industry, and that where special machines are required they should be allowed time to lay themselves out for their manufacture. The State administrations are not disposed to accord preference for national production to the extent of depriving arsenals and factories of the use of foreign machines which offer the fullest guarantee of good service. Nevertheless, every encouragement is given to national production, and the French industry is already in a position to supply most of what is required. The question now arises whether it will be able to monopolise the home market without protection of a magnitude which must be detrimental to users. There are some machines that can only be produced economically for the international market, and it is difficult to imagine that the French industry will be able to profit from foreign trade in competition with powerful manufacturing interests abroad that have the advantage of production facilities, long experience, and a world-wide reputation for special machines. Furthermore, a new industry may lag behind more fully developed foreign industries which may be prepared to meet new competition by introducing improved types of machines. It is not derogatory to French skill and invention to suggest that no country can make progress by completely closing its markets. The user must be able to select machines that suit him best. That power of selection may be left to him and still leave work for French machinery makers. It appears to be as unwise as unnecessary to place in the way of foreign machines obstacles that cannot fail to react on an export trade which is essential to the country's prosperity.

Temperament in Industry.

THAT infallible guide, the Oxford Dictionary, informs us that "complexes"—meaning mental kinks—were identified by Neisser in 1906. Before that no one knew that he suffered from them. Now, everyone is expected to be aware that he, and particularly his neighbour, are the involuntary victims of one or more of that kind of mental biases. Sometimes they do him good; sometimes harm. Sometimes they make him interesting to his fellow-beings; sometimes an insufferable bore. These complexes are part of every man's temperamental and psychological "make-up." They play their part in the direction which his activities take. The mechanical-complex, if sufficiently pronounced, makes the mechanical engineer; the money-complex may make the miser; the health-complex, in excess, makes the hypochondriac. Before this scientific discovery the world pursued its way much as it does now, but under the intolerable disadvantage that it did so without the sympathy and acquiescence of science. What a comfort it is to modern sinners to know that they are predordained to their particular vices by their temperaments; to those who want to do something that they ought not to do, that they are driven towards it by an overmastering complex; or to those who throw up their jobs that they are temperamentally unfitted for them! There was a time when common sense and a little hardness of heart dealt faithfully with complexes and temperaments. But science has changed, or is endeavouring to change, all that. In those days a boy was pitchforked into a job, or a youth into matrimony, and each was expected to make the best of it. Now people are busy devising charts, devices, and examinations for discovering the occupation for which each youth is fitted. There used to be a man not a hundred miles from this office who did that by feeling your bumps, and he proved by endless records that he was nearly always right. But phrenology is a dead and neglected science—it was a "science" in its day—and has been replaced by psychology.

That science, which leads us another little step on the road towards the removal of the responsibility of the individual, has for some years been invading industry. The National Institute of Industrial Psychology is the arch protagonist of this movement. It has published many researches and arranged many lectures. The second of a series of discourses on "The Temperamental Factor in Industry" was delivered before it on Monday last. Professor Major Greenwood, F.R.C.P., F.R.S., was the speaker, and Dr. A. S. MacNalty, Chief Medical Officer, Ministry of Health and Board of Education, was in the chair. Broadly speaking, we venture to say of Professor Greenwood's address that it was a luke-warm blessing. He surveyed with some detail the efforts that have been made by industrial psychologists to discover means of determining precisely the vocational fitness of individuals, and, if we have understood him aright, came to the conclusion that group analysis was moderately trustworthy, but individual analysis quite unreliable. If such methods are used to decide whether or not individuals are suitable for a particular industrial occupation, then, as Professor Greenwood admits, amongst those who are accepted will be a high proportion of suitable persons, but also a certain number of unsuitable individuals, while some suitable individuals will probably be rejected. Accepting this as a correct picture of the present position of psychological-vocational selection, it will be admitted that we have not got much further than the old system carried us. We may take it that predilection is as safe a guide as the new science. The majority follow their bent with tolerable success, a few find that it is not what they expected, and a few, owing to circumstances over which they had no control, are wasted in other vocations. It would seem that these new psychological tests can only be applied, where there is no predilection, where the subject has no notion what he wants to do. In such cases external forces get to work. Parents decide that a boy must work at something, and find him a job; or the necessity to make a livelihood compels the young man to accept any post he can get. It does, of course, happen that some round pegs get into square holes, but experience has shown that in ninety-nine cases out of a hundred the peg expands under the influence of its environment till it does fit the hole fairly well. The defect in the psychological method is that it does not make sufficient allowance for this plasticity in the majority. The inflexible cases, the men who cannot adapt themselves, either make by their own efforts their way to the end at which they would be, or join the army of failures. We doubt very greatly if any psychological examination can go much further than this, and we stand aghast at the thought that it might, in the course of years, discover that the world had developed a temperamental fitness for all the soft jobs, and that, scientifically, there was no justification for appointing any individual to the hard ones!

Professor Greenwood remarked that we are realising more and more the importance of temperamental factors in industry. If he had said that psychologists are realising it more and more,

the statement would no doubt have been true; but if by "we" he intended to include works managers and employers in general, we do not for a moment believe that it is justified. The employer and those in charge under him have always known that the temperaments of employees fit one for one job and one for another. The manager, being what Professor Greenwood calls an "artist," in contradistinction from a scientist, can pick out with few mistakes the man fitted to be made a charge-hand or a foreman, and the charge-hand or foreman, in his turn, soon discovers the class and kind of work for which each man is best fitted. But every employer recognises, and all the psychology that science can bring to bear will never weaken that recognition, that training and experience come before temperament. Temperament is, in fact, not nearly such a mighty influence as those who examine it under the microscope would have us believe. It is in the vast majority of cases something that can be modified or, if necessary, held in subjection. We are quite unconvinced that it is a factor of great importance in the workshop or the office, and we agree with Professor Greenwood, who near the end of his discourse said: "I cannot at present foresee a very useful place for quantitative measures of temperament in a scheme of vocational guidance."

The British Industries Fair at Birmingham.

No. II.

(*Continued from page 512, May 17th.*)

International Combustion, Ltd.

THE process of treating and recovering combustible material from coal slurry is demonstrated by International Combustion, Ltd., of Aldwych House, W.C.2. A model is used to demonstrate the firm's Hardinge thickener and Unifloc flocculating agent, consisting of a small copper tank through the side windows of which these agents may be seen at work. A 3ft. Rovac rotary vacuum filter is operated under actual working conditions using coal slurry as a feed. This filter, which is operated under vacuum, is made in various types and sizes for use in various industries. The principle will be clear from the engravings. The caked material which has been left behind on the drum is removed by the rotation of the drum. The agitator in the slurry trough at the bottom of the filter may be of various forms, either the paddle type or oscillating type. The filter drum, with its independent suction cells, each taking a small arc of the diameter, is rubber-lined to be acid-resisting

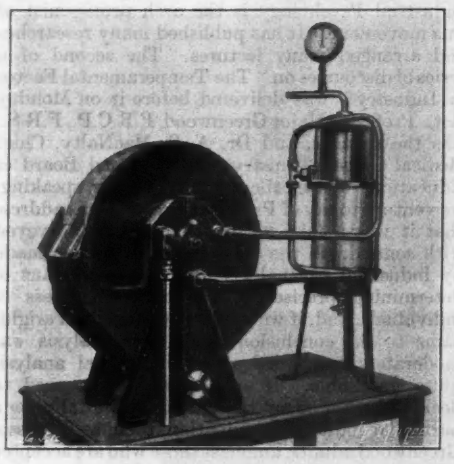


FIG. 12—ROTARY VACUUM FILTER—INTERNATIONAL COMBUSTION

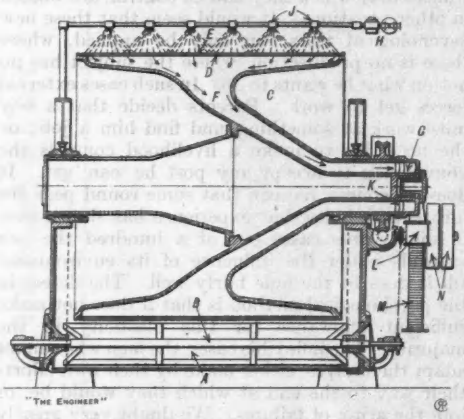


FIG. 13—SECTION THROUGH FILTER DRUM—INTERNATIONAL COMBUSTION

when necessary, and on its machined periphery the filter cloths are screwed. At the top of the strainer a washing spray is installed which softens the cake ready for discharging. The valve gear is all housed at one hub of the drum, and has replaceable plates for variation of lead, &c. Steam or compressed air is brought into the drum to blow through the filter screen to lift the cake, which is removed by a scraper knife set to contact with the drum surface. The illustration, Fig. 12, shows the complete filter installation, and a sectional elevation is shown in Fig. 13:—A, slurry trough; B, paddle (or oscillating) agitator; C, filter drum; D, perforated filter plate; E, filter cloth (metal gauze, cotton, linen, &c.); F, independent suction cells; G, valve head for suction, liquor separation, and releasing air; H, wash-water strainer; J, wash-water spray nozzles; K, renewable plates on valve head and drum; L, liquor sight glasses; M, flexible discharge pipes for filtrate; N, fast and loose drive pulleys.

Mavor and Coulson, Ltd.

One generally associates the name of Mavor and Coulson, of 47, Broad-street, Glasgow, S.E., with coal-mining machinery, but on this occasion the firm is represented by a machine more eminently suited for surface working. It is the loader represented in Fig. 14, and is capable of handling up to 4 cubic yards of material a minute. It is shown in the Fair grounds loading up sand and gravel.

FIG. 14—LOADING MACHINE—MAVOR AND COULSON

The machine comprises two belt conveyors in series and a gathering gear for drawing the material on to the lower flight. It can be pushed into a heap under its own power, and deliver the material at a higher distant point. The gathering action is produced by two arms, which swing and oscillate in a manner reminiscent of the action of a crab's claws. It is carried by caterpillar crawler tractors, and is driven by a 35 h.p. oil engine. The machine will deliver to a radius of 22ft. 6in. between a height of 7ft. 9in. and 14ft. 3in., and has a total length of 45ft. Its total weight is about 10½ tons.

Williams and James.

The problem of ensuring that everything is in order before finally connecting up to the main is one of the difficulties which faces every engineer in the laying of hydraulic lines and water piping generally. In order to cope with the need for some form of test, Williams and James, of Gloucester, have developed the "Hydraulux" mains testing plant, which we illustrate in Figs. 15 and 16. This plant, which is assembled in compact form with carrying handles provides a sure method of checking the adequacy of joints and the correctness of the work done by applying water under pressure up to 300 lb. per square inch to any section of the system. The machine consists of a twin-cylinder horizontal water pump with phosphor-bronze plungers working in gun-metal guides and glands. The suction and delivery valves are phosphor-bronze balls mounted in gun-metal cages and seatings. The pump is totally enclosed, but

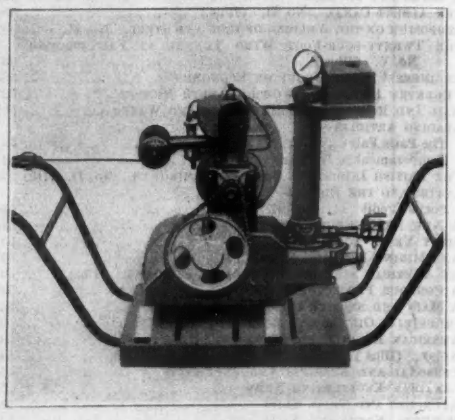


FIG. 16—MAINS TESTING PLANT—WILLIAMS AND JAMES

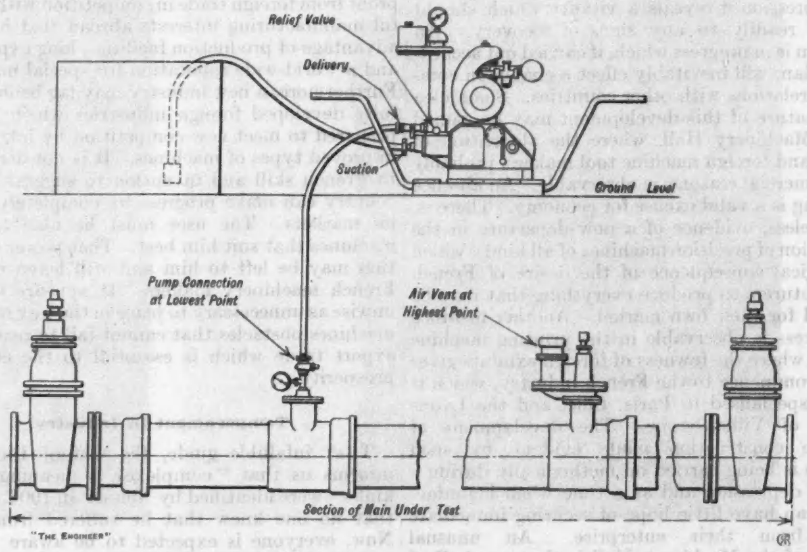


FIG. 15—ARRANGEMENT FOR TEST WITH "HYDRAULUX" PLANT—WILLIAMS AND JAMES

is fitted with inspection doors to enable inspection and adjustment of the glands to be made. The adjustment requires no tools. The pump plungers are driven by geared excentrics running in an oil bath which provides lubrication to all parts. Above the pump the 1½ h.p. Villiers two-stroke engine is mounted. It drives the pump by chain and is of the fly-wheel magneto type. The equipment is completed by 20ft. of high-pressure delivery hose and 6ft. of suction hose. The weight of the complete testing plant is given as 200 lb. Also to be seen on the stand is the "Hydraulux" tree spraying plant. This plant is similar to the mains testing plant, but is equipped with a spray gun and nozzles and delivers, it is said, 3·5 to 4 gallons per minute at 300 lb. per square inch. The machine has, we understand, numerous other applications, such as car washing, &c., where a portable source of high-pressure water is desired.

British Trane Company, Ltd.

On the stand of the British Trane Company, Ltd., of Newcastle-place, Clerkenwell, London, E.C.1, the chief exhibits are Univectair heaters of various types and for different applications. In Fig. 17 there is illustrated an all-electric unit comprising an electric fan which forces air past heating coils to the outlet on the other side of the casing. This unit is suspended from the roof or other suitable point in a factory or hall and vanes on the outlet side direct a stream of warmed air downwards. The natural state of any enclosed space in which a number of people are working is that the warm air shall be near

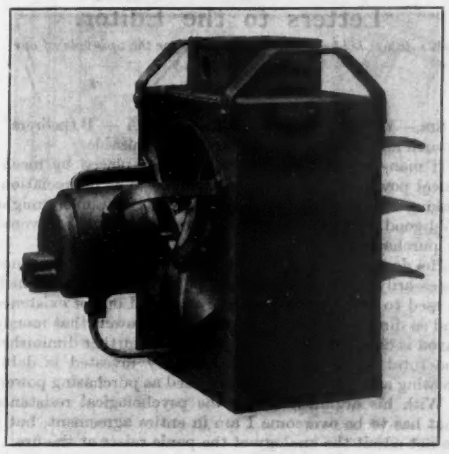


FIG. 17—"UNIVECTAIR" HEATER—BRITISH TRANE

the ceiling. Thus with Univectairs of this type in operation a continual circulation is developed, for the warm air rising naturally is further warmed and driven downwards, while any cold air that may enter the room is also displaced upwards to pass through the heaters. Similar devices, almost identical in appearance, are made for use with steam as the heating medium. In this case heavy copper tubes are expanded and ferruled into cast iron headers. Each header is tested up to 300 lb. per square inch pressure, and the construction is guaranteed to be safe and leak-proof for steam pressures up to 150 lb. per square inch. The units are constructed in a range of sizes for fifteen different output capacities, the smallest

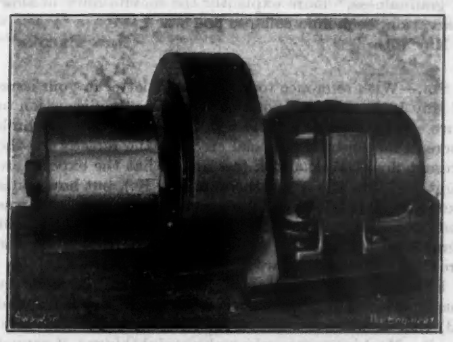


FIG. 18—MECHANICAL DRAUGHT CONTROLLER —BRITISH TRANE

being suitable for a room, 10ft. by 25ft., and the largest for an area of 7500 square feet. For larger areas, of course, more than one unit can be used.

A new development exhibited on the stand is the floor type Univectair. This device works on a principle similar to the ordinary type, but since it is placed on the floor is enclosed in a handsome sheet metal cabinet. In operation it is thermostatically controlled. When first started it draws in air from above, heats it and discharges it at floor level, where normally the air is coolest. When the temperature at this level has risen to the required degree, a thermostat operates to stop the fan. In consequence, the warmed air delivered to the floor gradually rises towards the ceiling, and the floor temperature tends to fall. This reduction of temperature operates the thermostat again, so that the fan is restarted. The warm air is then drawn from the ceiling level and re-delivered to the floor. When the fan is not in action the device operates as an ordinary convection heater, since air will naturally rise through it being warmed in the process. Floor type Univectairs can be all-electric or electric and steam operated.

Of perhaps more direct interest to engineers is a bellows trap, the function of which is to allow air and water to pass, but to stop the passage of steam. The body of this device is made of brass. Inside the body there is a bellows-like, thermostatic member made of seamless, jointless corrugated brass, 1¼in. diameter, carrying at the lower end the male part of a cone valve. Before the bellows will contract sufficiently to open the outlet it is necessary for any steam present to condense. This bellows contains a liquid, the vapour pressure of which at any temperature is about 6·7 lb. per square inch above that of steam. Thus high pressures accidentally applied to the trap will not harm it.

Another exhibit of considerable interest is the mechanical draught control. When forced draught fans are fitted to heating boilers and are thermostatically controlled, a considerable natural draught is induced through the inlet and runner when the fan is shut down. This draught results in wasteful consumption of fuel, during periods when the boiler load is low, and may also be sufficient to make close regulation of steam pressure or water temperature difficult to obtain.

The control apparatus exhibited is designed to obviate this by automatically closing the fan inlet when the motor is cut out of circuit by the thermostat. The control unit, Fig. 18, consists of a centrifugal blower fan and motor, on the extended spindle of which is mounted the control mechanism. The motors are of the totally enclosed ball bearing pattern, running at a speed of 1400 r.p.m. in all cases, and the fan is of the multivane type. The mechanism consists of a damper disc sliding on an extension of the motor spindle, so as to lie flat against the inlet opening of the fan when in the closed position. It is held in this position by a spring when the fan is stationary, but as soon as the motor starts up the disc is withdrawn along the spindle against the pressure of the spring by means of an arrangement of links and weights. These revolve with the spindle, and act in the well-known manner of the centrifugal governor. The whole mechanism is protected by a spun aluminium casing which is adjustable along the spindle, and forms a stop to limit the travel of the disc and is adjustable to give various air quantities up to the maximum.

The Brightside Foundry and Engineering Company, Ltd.

On the stand of the Brightside Foundry and Engineering Company, Ltd., Sheffield, 1, there are some interesting rolls for the cold and hot finishing of metal strip and such purposes, which are remarkable for the hardness of their surface without detracting from their toughness. Hardness numbers of the order of 85 to 90 on the Shore scale are obtained. There are also on this stand an air-conditioning plant and the mechanical stoker, of which we give a drawing in Fig. 19.

This latter machine is intended for firing comparatively small furnaces, such as those of central heating boilers, and provides a fire on the coking principle—that is to say, the fresh coal is pushed into the lower part of the fire, so that its volatile constituents are ignited as they pass through the fire above. The fuel is placed in a hopper below which there is a screw conveyor driven through a gear-box by a small

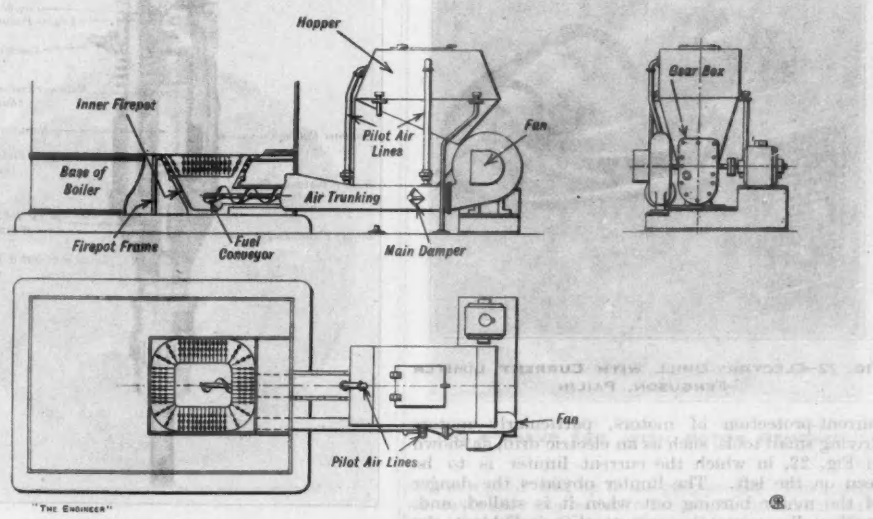


FIG. 19—MECHANICAL STOKER—BRIGHTSIDE

electric motor. The conveyor forces the coal along a duct into a "pot" in the furnace. This pot is equipped with fire-bars in such a manner that as the fuel rises in the centre air is admitted at the sides. The air is supplied by a fan driven by the same motor as the screw. A thermostat is used to control the motor, and there is a further control, operated by clockwork, which comes into action in the event of the temperature control shutting down for a long period, and starts up the fan again for a short period to prevent the fire going out entirely. The driving motor is of ¾ h.p., and the gear-box gives six speeds for the fuel conveyor. The machine is made in seven sizes with outputs ranging from 225,000 to 2 million B.Th.U. per hour.

Priestman Brothers, Ltd.

In the outdoor section of the Fair, Priestman Brothers, Ltd., of Holderness Foundry, Hull, are exhibiting two excavating machines, one of which is illustrated in Fig. 20, where it is shown equipped

FIG. 20—QUARTER CUBIC YARD EXCAVATOR WITH TEREDO TRENCHER—PRIESTMAN

with a Teredo trenching scoop. It is known as the Cub ¼ cubic yard universal excavator, and is a new model. One of the novel features is a live ring of rollers, which adds considerably to the ease of the slewing motion and improves the stability factor. The Teredo scoop with which it is fitted is claimed to be the only single-arm trencher for operation from a universal excavator which will cut trenches 1ft. in width.

The Teredo is worked from the standard trencher

"Panther Twelve," which also is universal and carried on crawler tracks. Only two jibs are required for eight attachments. It is 12 cubic feet capacity, and is shown working one of the "Level-Cut" big-spread grabs at the end of a 40ft. boom. These grabs, which have already been described in THE ENGINEER, have a linkwork which makes the lips of the buckets travel in a level horizontal path as they close. As a dragline the machine will work a 12 cubic foot scoop at an outreach of 40ft., or a 7 cubic foot at 55ft. reach. The superstructure revolves on a large-diameter live ring of rollers, and the undercarriage is of all-welded steel construction with totally enclosed machine-cut gear transmission for travelling.

FERGUSON, PAILIN, LTD.

Industrial and motor control gear is to be seen on the stand of Ferguson, Pailin, Ltd., of Higher Openshaw, Manchester. Fabricated construction has been adopted to meet the arduous conditions met with in factories and high-pressure line contacts,

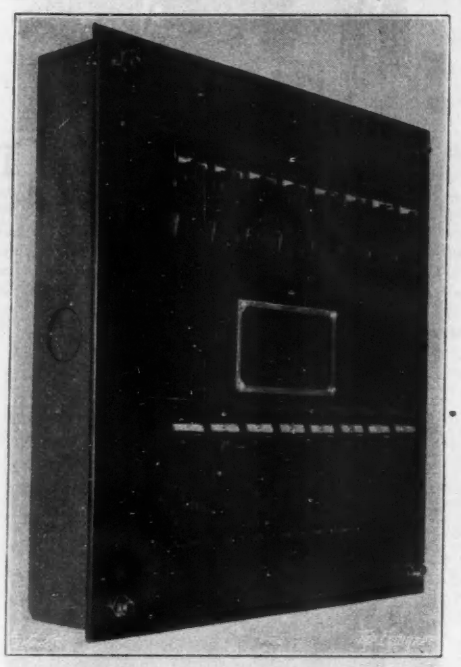


FIG. 21—THERMAL CIRCUIT BREAKERS—FERGUSON, PAILIN

reversible main and arcing contacts, and simple operating gear are among the special features of the gear. For industrial use the firm is showing miniature thermal circuit breakers—Fig. 21—and a magnetic current limiter. The former will protect A.C. circuits up to 30 ampères, and offer the advantages over fuses that their operation under fault conditions is indicated, whilst the exposure of live parts and the operation of rewiring are avoided.

The current limiter is capable of many applications where over-current protection is required. It is suitable, for example, for current limiting in connection with a fixed load tariff, and for the over-

FIG. 22—ELECTRIC DRILL WITH CURRENT LIMITER—FERGUSON, PAILIN

current-protection of motors, particularly motors driving small tools, such as an electric drill, as shown in Fig. 22, in which the current limiter is to be seen on the left. The limiter obviates the danger of the motor burning out when it is stalled, and, incidentally, saves the current that is liable to be wasted under those conditions. The device may also be used for protection against earth faults and for various other purposes.

NEGRETTI AND ZAMBRA.

A variety of measuring instruments for steam, gas, oil, water, and for pressure, temperature, humidity, &c., is exhibited by Negretti and Zambra, of 38, Holborn-viaduct, London. Automatic controllers are also to be seen, those for temperature including indicating, non-indicating, and one or two-pen recording types. Mercury in steel thermometers in many applications are, of course, to be seen, and thermo-electric controllers for furnace control, in which electricity is the auxiliary power and all contacts are operated by a synchronous motor. Mercury tube switches are used for all contacts. In connection with humidity controllers there is a new development in the irrigation of the wet bulb from a steam supply by which means a constant feed of clean distilled water is ensured. Thermo-couple

FIG. 23—INDICATING PYROMETER AND THERMOMETER—NEGRETTI

pyrometers are exhibited in both indicating and recording types, and in the latter class there is a new multi-point model with a strip chart 50ft. in length. The illustration, Fig. 23, shows an indicating instrument combining both thermo-couple and electrical resistance principles, so that high and low readings are obtained on one scale. In the design of all the instruments made by the firm, although prime consideration is given to accuracy, sensitivity and reliability, it is realised that robustness is of great importance for industrial use.

WARSOP PETROL DRILL AND TOOLS, LTD.

On the stand of Warsop Petrol Drill and Tools, Ltd., Milton Chambers, Milton-street, Nottingham, there are shown two types of petrol-driven rock drill

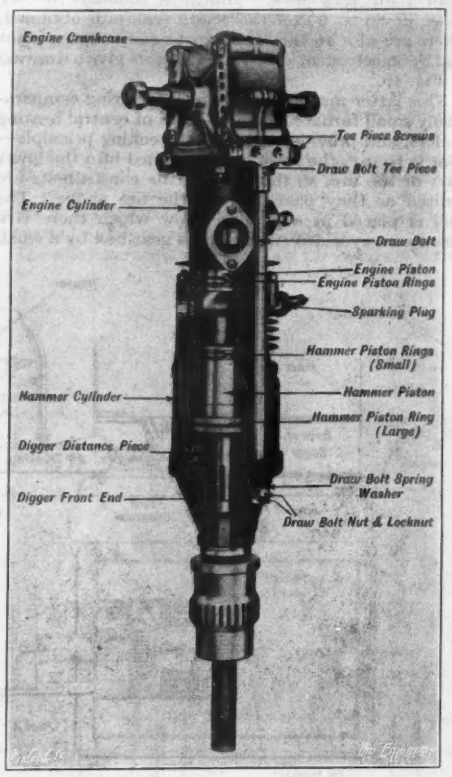


FIG. 24—PETROL ROAD BREAKER—WARSOP

and road breaker, one of which we illustrate in section by Fig. 24. These machines are self-contained and only require to be supplied with petrol to start work anywhere. The action of the machine might be described as using the cylinder head of a petrol engine as a hammer.

On reference to the engraving it will be seen that there are no working valves or springs. The upper portion of the machine is an inverted two-stroke petrol engine of a standard type, which has been in use for many years and is of proved reliability. The lower portion consists of a hammer cylinder containing a hammer piston of the type in use for a considerable time in pneumatically operated road breakers; the hammer piston, which is of two diameters, is free to float between two air and gas cushions at the top and bottom of the large diameter. In working, the explosion which takes place between the two opposed pistons when together forces them apart, the hammer piston striking the road breaker steel and the engine piston completing the full cycle of the two-stroke engine. The return of the hammer piston is effected by the admission of gases to the underside (large diameter) of the hammer piston, through the by-pass port which is uncovered by the engine piston during its upward stroke. The standard petroil system of lubrication is employed and ensures complete and positive lubrication throughout the whole machine. Ignition is effected by standard fly-wheel magneto (not shown in the engraving). A single lead to the sparking plug (without an ignition switch) ensures complete ignition reliability. Cooling is effected by a simple fan carried on the opposite end of the crank shaft to the fly-wheel, which provides a constant stream of cool air down the whole length of the machine and past a set of cooling fins.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SOCIAL CREDIT.

SIR,—Mr. Vowles has simplified the "A + B theorem" to such an extent that it is barely recognisable.

If man-power had not largely been replaced by mechanical power, if there were no such costs as depreciation, sinking fund, interest on loan, &c., his statement might hold good, that all the costs of production were recovered in purchasing power.

He does not mention that money paid out does not necessarily increase purchasing power, that money which is used to repay debt is merely cancelled out of existence and so diminishes the total purchasing power, that money saved is deferred purchasing power and further diminishes the total operating, and that money invested is debt-creating and can only in part be used as purchasing power.

With his argument as to the psychological resistance that has to be overcome I am in entire agreement, but I do not admit the analogy of the panic raiser at the fire.

There is nothing panicky about the social credit movement; the scaremongering is rather to be found in the circles of orthodoxy. Not so long ago the President of the Board of Trade was reported to have said that in the event of a Socialist Government being returned he would take his money out of the country.

The present Government came into office on a panic cry of stick to the gold standard. Yet it was the bold experiment of quitting it that saved the situation.

Mr. Vowles counselled engineers to study logic, but the logic of events is urgent and inescapable.

What has he to offer in place of the National Dividend and Discount proposals? Is he content with a system that seeks national prosperity by mass impoverishment, and destroys goods rather than sell them for use, and which immobilises the natural markets by withholding purchasing power? Or is he a believer in "the inevitability of gradualness," more explicitly the inevitability of slow starvation, economic collapse and war?

May 19th. NEW BRITON.

SIR,—With reference to Mr. Ryden's letter in your issue of May 10th, if it were possible to confine the discussion to pure economics and let the rest "go hang," then I think there is no doubt that social credit is the remedy for the present financial deadlock (assuming that the experts are right and that the A+B theorem is O.K.), but how can a world like this be kept to pure economics? All I said was that if the present financial difficulty were solved without demechanisation, then we should be confronted by the problem of leisure. So we should; we already are.

I only postulate that all useful things will be made by machinery, because (A) that is what machinery is for, and (B) that is what is claimed for machinery by those who use it. Machinery can only make useful things; it cannot do ornamental things, though, of course, it can supply reproductions (Medici prints and such like). And obviously if people have a lot of leisure and spend that leisure making useful things by hand, they will inflict serious competition on the factories, they will have to be told that what they make in their leisure time must be useless. In fact, industrialism and machine production has released us for "higher things," but you cannot confine the discussion to pure economics. ERIC GILL.

High Wycombe, May 17th.

AT the first meeting of the new Council of the Society of Motor Manufacturers and Traders, Ltd., held on May 16th, Mr. Peter F. Bennett, managing director of Joseph Lucas, Ltd., Birmingham, was elected President of the Society for the year 1935–36, in succession to Sir Herbert Austin, who was elected as Deputy President. Mr. W. E. Rootes and Mr. W. Cowen were elected as Vice-Presidents.

A New Axial Engine.

A DEPARTURE from the conventional design in petrol engines is often accompanied by practical weaknesses and errors of detail design that place it automatically in the class of an experiment, and render its practical value to the engineer questionable. A new engine demonstrated last week is far from coming into the experimental class. This is the "axial wobble plate" engine, developed by the Bristol Tramways and Carriage Company. The engine is sponsored by the works manager, Major C. G. Nevatt, whose practical experience has ensured that the detail design is unquestionable on the score of ease of manufacture or reliability. The engine has been built deliberately to have the same capacity (7 litres) as the standard omnibus engine produced by the company. The advantage of this for comparative purposes is obvious. To the clear and unbiassed explanation of the principles involved in the engine, Major Nevatt was frank enough to add a history of previous failures which the firm had had with earlier models. He also presented for inspection the damaged portions of these engines, and gave the reason for their failures.

The engine in its present form is shown in section by Fig. 1. It will be seen that it is exceedingly compact; in fact, the reason for its development was to increase the passenger-carrying capacity of a Bristol chassis by decreasing the space occupied by the motor. If the engine height can be decreased, the driver can be seated above it, and passenger space be gained on either side just behind him.

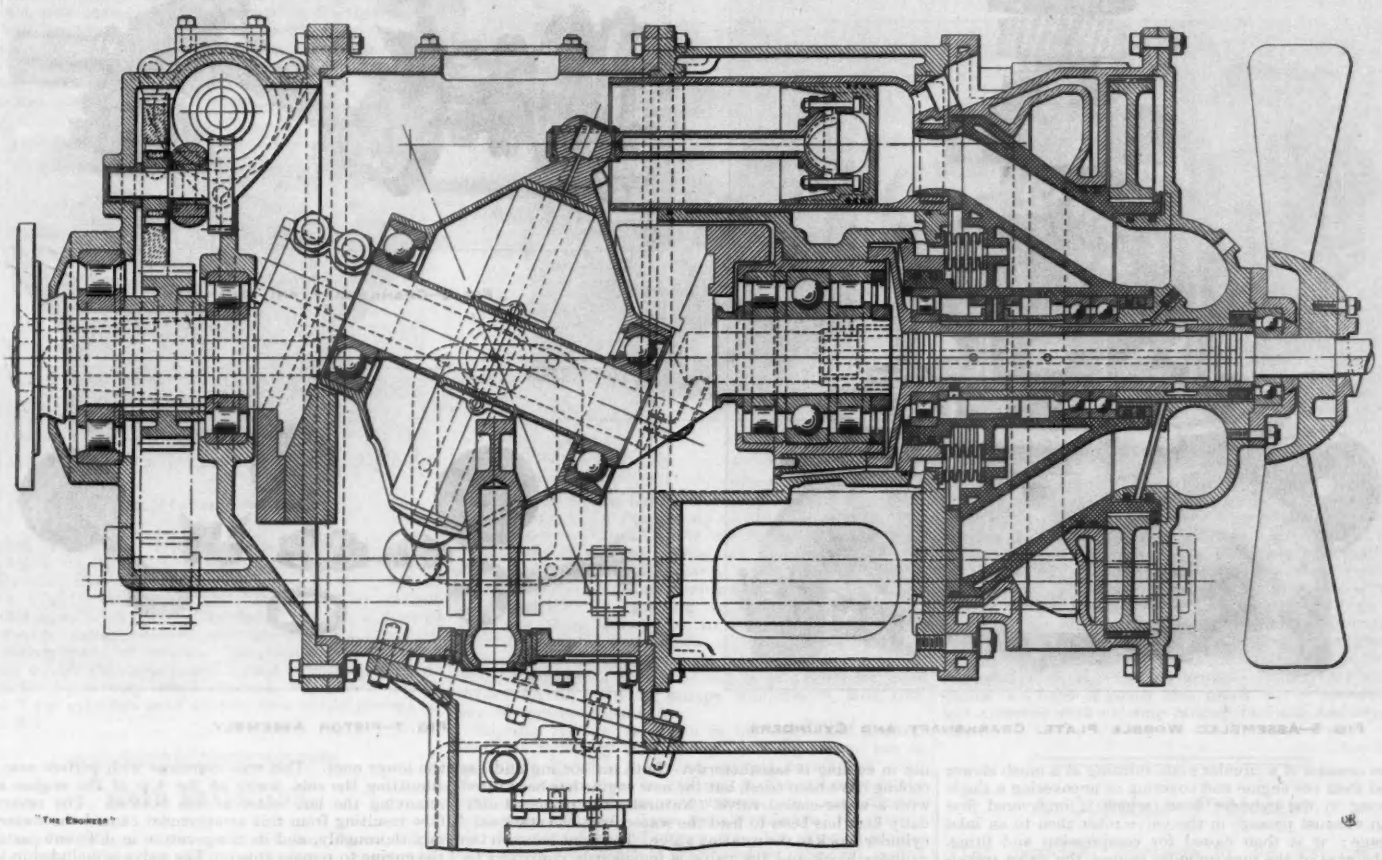


FIG. 1—LONGITUDINAL SECTION OF "AXIAL WOBBLE PLATE" ENGINE

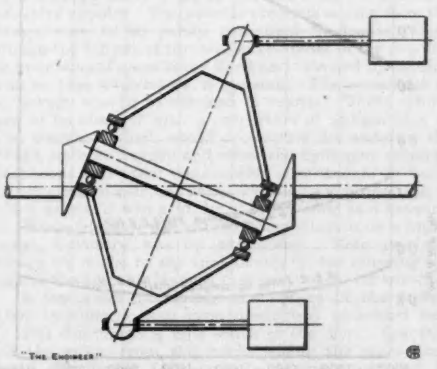


FIG. 2—ARRANGEMENT OF "WOBBLE PLATE"

The principle on which this engine works is that of the "swash plate," but the plate is a non-rotating member, mounted on a Z-shaped shaft, as illustrated diagrammatically by Fig. 2. This member is star-shaped, and is connected at the points of the star with the pistons through connecting-rods. The action of the pistons rocks the member about its central point. As each piston operates in turn a rotary motion is transmitted to the Z-shaped shaft, which passes through the centre of the member.

The advantages of such a design are as follows:—The cylinders lie in a compact group instead of being in line along the shaft. Very nearly straight-line thrust is obtained for the piston. The grouping of the cylinder heads together makes the valve gear compact. The short shaft which replaces the crank shaft is much stiffer and can be carried in bearings which may be of almost any size, being independent of the cylinder dimensions. The number of cylinders is not governed by the length of the crank shaft, so that increasing it does not increase the cost or size of the engine nearly as much as it does in the conventional design.

The disadvantages of the type are well known to hydraulic engineers and others who have experience of the "swash plate" design. They relate to the balancing of the engine, both statically and dynamically, and to the difficulties of lubrication, &c., which occur when the cumulative stresses due to out-of-balance thrusts coincide in certain points of the machine. Major Nevatt claims that these forces have at last been satisfactorily balanced, whilst, thanks to the design of the star-shaped member and its mounting on the Z-shaped shaft, no restrictions are imposed on the size of any moving parts. It is admitted that a couple remains in this mechanism tending to twist the webs of the shaft, but owing to the shortness of the shaft and to the freedom which the designer has as to dimensions, these webs can be made big enough to take the load. The whole mechanism is actually exceedingly robust, and the bearings are of unusually big diameter and surface. These are ball bearings, as are the shaft bearings throughout the engine.

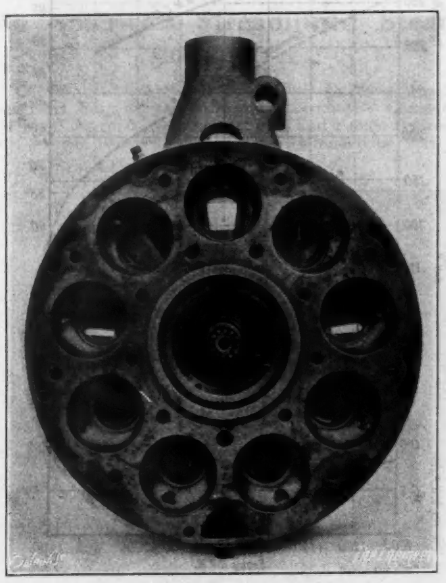


FIG. 3—COMBUSTION HEAD

It has taken two years for the company to perfect this engine, and five of its predecessors have been tested to failure. In the beginning the problem of balancing the star plate with its attached bearings, &c., proved a stumbling block. It was solved eventually by suspending it from one of a pair of watch springs. The other was loaded with an equivalent weight. When both were set rotating together, the weight was adjusted until it exactly reproduced the rotations of the star member. The weight had then the same inertia characteristics as the star member. The star member was reversed and both were again set in motion. Any divergence on the part of the star member from the "beat" set by the weight was rectified by the temporary addition of weights to the star member. This process was repeated for all positions of the star plate until it was certain that the plate had the same inertia in all positions and was therefore balanced about any diameter.

The next difficulty experienced was met in a seven-cylinder model, designed to replace the Cirrus engine of a Moth aeroplane. Actually, the engine had already been flown, and the fault developed when it was replaced on the test bed after use in the air. The connecting-rods used between the star member and the piston on this engine were attached to the piston by a gudgeon, which prevented relative rotation of the connecting-rod and piston. A break occurred simultaneously on all seven connecting-rods at a point close up to the gudgeon pin. This failure was easily shown to be due to fatigue, but it was not until later than Major Nevatt discovered the reason. The piston receives a "figure of eight" rotary motion in its travel, owing to the characteristic motion of the star member. At a certain critical speed the inertia of the piston was sufficient to stop this motion entirely, and it merely reciprocated. Naturally, this produced a torsional fatigue stress on the connecting-rod, which luckily did not succumb until after its flying tests were over. These joints are now of the ball type.

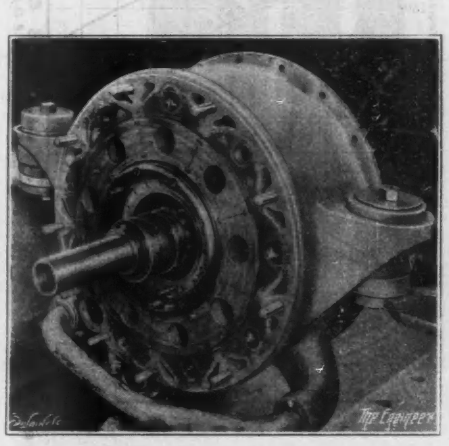


FIG. 4—VALVE END, WITH ROTOR REMOVED

The exactness with which the seven fractures occurred together speaks well for the balance of the engine and the

uniformity of the material. This incident satisfied Major Nevatt as to the balance of the engine. He was not satisfied with the complexity of the valve gear, which up to this time had been of the ordinary poppet type. In order to arrange fourteen push rods, rockers, cotters, valve springs, valves, and fourteen sparking plugs, all in the small available space, accessibility had to be sacrificed to an extent not satisfactory for omnibus work. Accordingly the orthodox system was superseded in favour of a single rotary valve. This forms another interesting feature of the new engine. In principle, the rotary valve consists of a circular plate rotating at a much slower speed than the engine and covering or uncovering a single opening in the cylinder head, which is uncovered first to an exhaust passage in the valve rotor then to an inlet passage; it is then closed for compression and firing. In the case of the nine-cylinder engine, the valve travels at one-tenth of engine speed. The engine fires on Nos. 1, 3, 5, 7, 9, 2, 4, 6, 8 cylinders successively, so that in its rotation the inlet port which feeds No. 1 cylinder only feeds No. 2 cylinder after the engine has passed through 400 deg.

The first difficulty to be overcome in such a valve gear lies in providing a satisfactory compression seal between the cylinder and the rotary valve. Fig. 1 shows the method adopted for this. A small cylinder is fitted to the opening in the cylinder head, like a crownless piston. Rings around it similar to piston rings make the joint satisfactory. The piston at its outer end is brazed into a flat plate which is spring-loaded and forms a sector of a circle completed by the eight similar sectors. These plates are in rubbing contact with the valve face and distribute the explosion pressure from the cylinders over the maximum possible area of valve. A certain amount of trouble was experienced at first, owing to excessive wearing of the valve face. It was then found that the explosion pressure on the wall ends of these pistons was excessive, even when distributed over the area of valve covered by the plates. To overcome this trouble a radius was made at the point where the piston walls entered the plates. This radius enabled the explosion pressure to act on both ends of the piston walls and balance itself. It must be remembered that the piston is always in communication with the working cylinder like an extending tube from it to the valve face. Phosphor bronze is used for the construction of these pistons and their plates, as it provides a suitable surface for the valve to rub on and does not oxydise under the influence of the exhaust gas temperature. The valve itself is now a steel casting.

Another difficulty which arises with a single rotary valve lies in cooling it satisfactorily. Both air cooling and gas cooling have been tried, but the new engine has been fitted with a water-cooled valve. Naturally the principal difficulty here has been to lead the water from the stationary cylinder block to the rotating valve. The joint between the cylinder block and the valve is ingeniously contrived by means of two "packless" joint rings of different diameters. The water passage is the annulus formed between them. This method has proved perfectly satisfactory.

A criticism of the slow-speed rotary valve might be that its action is too slow in opening or closing, and that the lap and lead are difficult to arrange. Against this, however, Major Nevatt pointed out that nearly the whole cylinder head was opened for an inlet or exhaust passage, so that these points lost their importance, in view of the large valve areas available. Various tests have been carried out on this valve gear. Lubrication was at first believed to be a somewhat vulnerable point. To test this, an engine was run for fourteen hours with the valve rotor dry of oil. Naturally considerable wear took place on the valve face, but we understand that the engine never "missed a beat," so that apparently the valve will stand up to abuse! We illustrate this particular valve after its ordeal in Fig. 11.

It will be realised that with a single annulus provided as a water passage, no attempt has been made to adopt any directional flow for the cooling water in the valve. Actually, some difficulty was experienced in maintaining the same temperature for all cylinders, owing to their position. At first the upper cylinders became hotter than the lower ones. This was overcome with perfect ease by admitting the cold water at the top of the engine and removing the hot water at the bottom. The reversed flow resulting from this arrangement caused the water to mix thoroughly, and its temperature in different parts of the engine to remain steady. The valve is included in this arrangement, as it forms an alternative path for the water in parallel with the cylinder block.

Lubrication of the engine proved simple. Dry sump forced lubrication is provided for the Z-shaft bearings, and the star member bearings. Sufficient oil for the connecting-rod joints and pistons is provided by a small jet set at the bottom edge of the cylinder. The operation of the valve with its reduction of speed is carried out from the distribution gears at the driving end of the shaft by means of a lay shaft.

The carburettor, which is of standard design, is connected to the inlet annulus at the front of the engine. As a whole, the engine contains no unorthodox lay-outs or parts, except as far as is necessary to carry out the initial idea. All other parts are built on perfectly orthodox lines.

In performance, this engine has satisfied the Bristol Tramways and Carriage Company as to its superiority over their own "J W" type six-cylinder omnibus engine. Figs. 8, 9, and 10 are performance curves for the two engines.

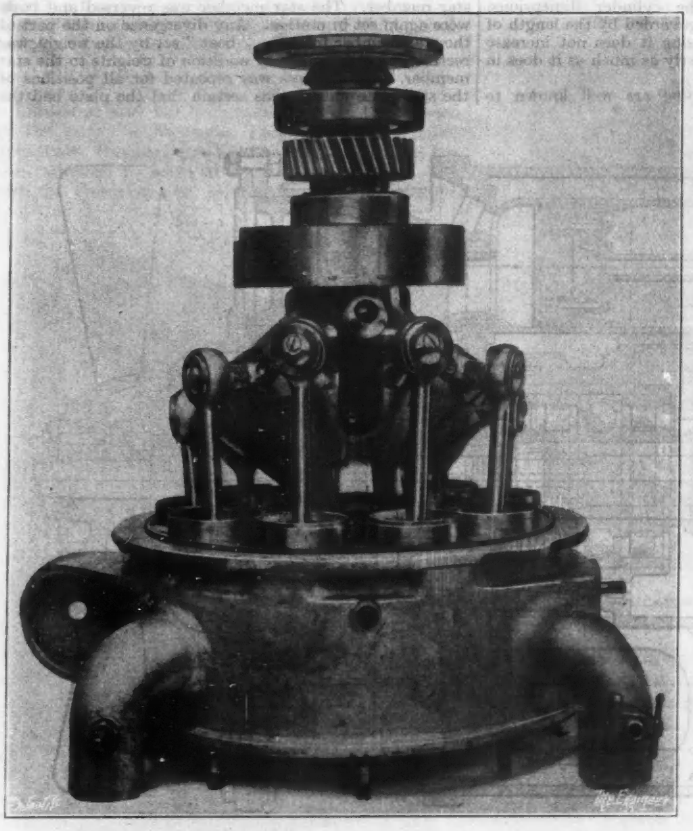


FIG. 5—ASSEMBLED WOBBLE PLATE, CRANKSHAFT AND CYLINDERS

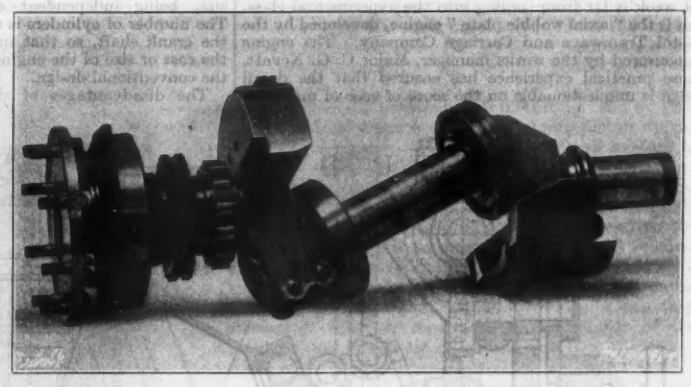


FIG. 6—CRANKSHAFT AND BEARINGS

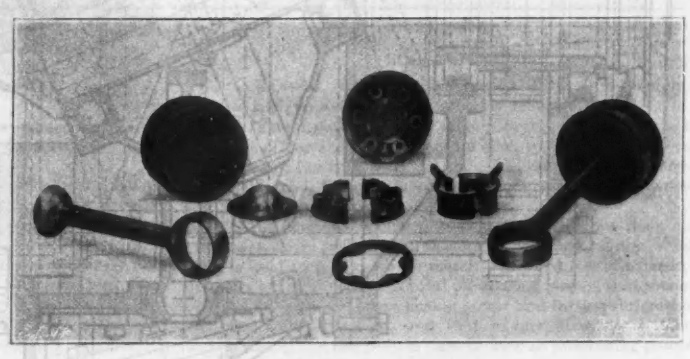


FIG. 7—PISTON ASSEMBLY

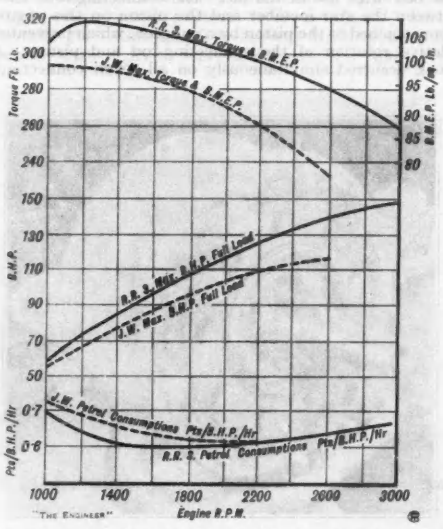


FIG. 8—COMPARISON OF FULL POWER AND B.M.E.P. CURVES

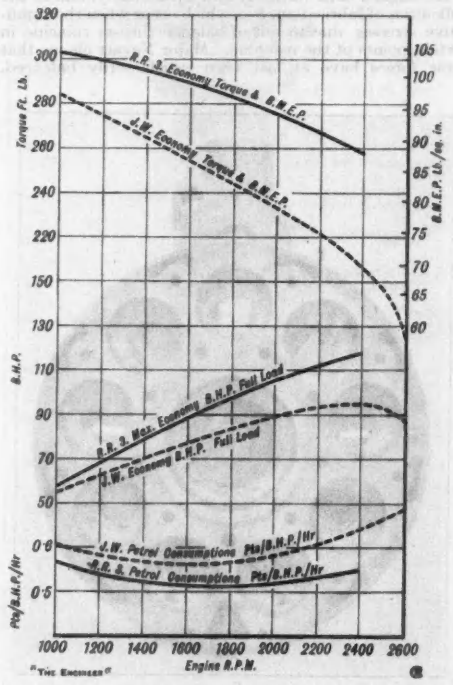


FIG. 9—CHARACTERISTIC CURVES AT ECONOMY CARBURRETOR SETTING

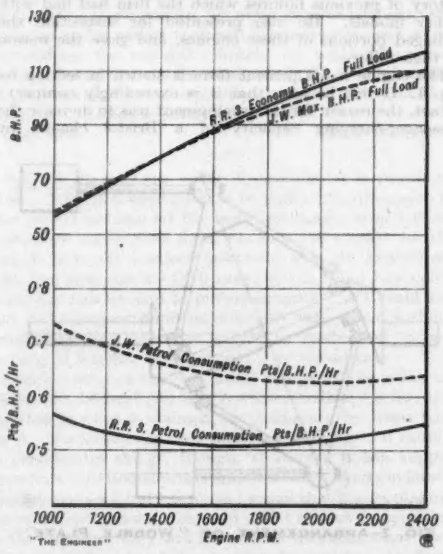


FIG. 10—COMPARISON OF CHARACTERISTIC CURVES

Fig. 10 requires a word of explanation in that it shows the performance of the new engine with its carburettor set for maximum economy, compared to the "J W" engine set for maximum power. This method produced approximately similar brake horse-power curves, and shows the full attainable economy with the new engine. A study of Fig. 8 will show a curious drop in horse-power and torque on the new engine below 1200 r.p.m. This, Major Nevatt explained, was due to too small a choke tube in the carburettor. The horse-power curve clearly shows that considerably more than 3000 r.p.m. is attainable on the new engine. We understand that this is not made use of largely to avoid altering the gear ratios of vehicles in which the engines will be tested. These are to be standard omnibuses running in Bristol, six of which are to be fitted with the new engine in the near future.

It is interesting to note that the lack of friction in the new engines was shown by the current taken when motoring the two engines on the test bed; 10 ampères sufficed for the new engine, against 40 ampères for the "J W." As both were motored by identical tramway motors on the same circuit, and as the water and oil temperatures were the same, this test seems quite conclusive.

The claims for the new motor are improved compactness and performance. In addition, its weight even at the present state of its development is 7 cwt., as against 12 cwt. in the "J W" type. In cost of manufacture, we understand that the experimental models have cost no more than a standard engine, largely owing to the smaller number of parts. The design has the additional advantage that increases of power are easily accomplished. An enlargement of cylinder bore, for example, which would double the horse-power, would increase the engine diameter by a very small amount, while to "double bank" the cylinders with another nine would present no difficulty.

FIG. 11—THE ROTOR

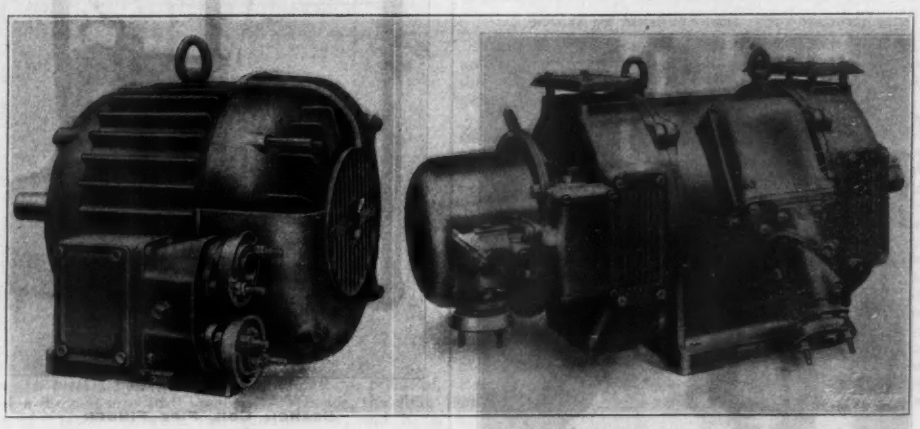
SIXTY YEARS AGO.

IT used to be said, with more of wit than delicacy, that if the Clyde had been the making of Glasgow it was equally true that Glasgow made the Clyde. On May 17th, 1875, Sir John Hawkshaw, under her Majesty's appointment, opened a court of inquiry into the pollution of the river. That the jibe was true in those days may be inferred from the fact that according to one witness thirty-five million gallons of sewage were thrown daily into the Clyde within the Glasgow area exclusive of the rainfall which varied between the same figure and twice that amount. Many schemes were laid before Sir John. We need give the outline of but one of them. Mr. A. G. Thomson proposed a plan for purifying the sewage in the immediate neighbourhood of the city. To reduce the quantity of matter to be treated he would keep the rainfall separate from the sewage and render compulsory the provision of apparatus for restricting the quantity of water used for flushing purposes. The diminished volume of sewage was to be conveyed through intercepting sewers into receivers furnished with lofty cupolas. The gaseous products arising from the sewage were to be partly consumed by leading them through the ashpits of furnaces at the bases of the cupolas, the ammoniacal gases being fixed and retained by causing them to pass over layers of gypsum. The remainder of the sewage was to be calcined in retorts. These retorts were to be charged with a proportion of sodium (*sic*) or other chemical which would decompose the water of the sewage, seize its oxygen and cause the hydrogen, sulphur, phosphorus and other combustible constituents to burn. The remnant of calcined ashes containing a proportion of potash would, it was held, be of some value as a manure. . . . While Glasgow was still debating what to do with its sewage, Coventry was up and doing. More precisely perhaps we ought to say that Coventry was allowing the General Sewage and Manure Company to do its work for it. A few years previously the sewage of the town's 40,000 inhabitants had been discharged untreated into the river Sherburne a mile south of the city. Together with the refuse from the works within the area—then largely silk dyeing factories—the sewage amounted to about two million gallons per day. It was described as extremely foul and highly coloured. Lower down the river joined the Avon and contributed to the water supply of Warwick. In our issue of May 21st, 1875, we recorded a visit to Coventry's new sewage works which had then been in operation for about a year. Solid matter was removed by a Latham extractor. The liquid portion then passed into vats where it was mixed with crude sulphate of alumina and boiled. Passing on the mixture was treated similarly with milk of lime and then delivered into settling tanks where precipitation occurred. The clear effluent was filtered and finally discharged into the river. The precipitated sludge remaining in the settling tanks was dried. The drying of the sludge, we noted, had always been an obstacle to the success of any precipitation process. The Coventry company was therefore trying a new method by which the drying was effected by a process of chemical desiccation which did not involve the application of heat. Ground mineral phosphate of lime, such as coprolites, was mixed with the semi-fluid sludge and sulphuric acid added to the mass. These chemicals yielded sulphate of lime and ordinary superphosphate. The sulphate took its water of combination from the sewage while the superphosphate remained to increase the manurial value of the product. The sludge after treatment in this manner was stated to be in the form of a gray, friable earth.

A.C. Mining Motors.

SQUIRREL-CAGE and slip-ring motors for mining service, either on the surface or underground, where complete flameproof enclosure is not demanded, have been brought to our notice by the British Thomson-Houston Company. They are made for outputs up to about 50 h.p. at 1000 r.p.m., and are suitable for use in damp, dirty, and inaccessible situations. They are also claimed to be capable of working satisfactorily where the load imposes severe vibration. As in mining service there is usually no objection to starting squirrel-cage motors by switching them directly on to the mains, the control gear is simple, and when a considerable starting effort is required, a high-torque motor can be provided. Thus, machines of this kind can be employed for most mining drives, including pumps, compressors, fans, conveyors, screening plant, &c.

Slip-ring motors, as shown in the right-hand illustration, are necessary when a high starting torque has to be obtained with a minimum starting current, or when the acceleration must be gradual, as, for example, in the case of ram pumps or compressors, with considerable friction and inertia. They are also essential for driving variable-speed fans and pumps, &c. The slip-ring motors have brush gear which is unaffected by vibration, and it is normally enclosed in a dustproof cover, although a flameproof cover, which conforms with official requirements, is also available. The left-hand illustration shows a totally enclosed fan-cooled squirrel-cage motor for Y-delta starting, and the right-hand picture a 45 h.p., 975 r.p.m., screen-protected slip-ring motor with a dust-tight slip-ring enclosure and slip-ring short-circuiting gear.

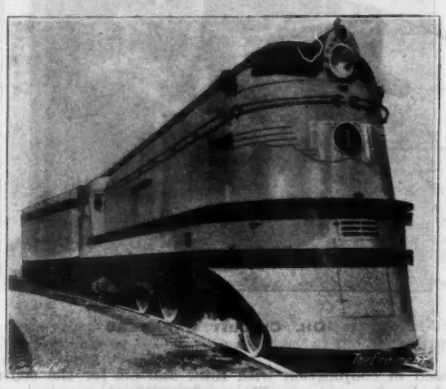


A.C. MINING MOTORS

An American Streamlined Steam Locomotive.

THE streamlined steam locomotive illustrated below has been built by the American Locomotive Company for the Chicago, Milwaukee, St. Paul and Pacific Railroad for service between Chicago and Minneapolis. It is designed to operate at top speeds of 80 to 100 miles an hour with few stops and starts but with numerous slow-downs to 40 or 50 miles an hour. Over a considerable range of speed it is stated to develop a sustained output of about 3000 h.p. Wind tunnel tests satisfied the builders that at high speeds the adoption of streamlining reduced the air resistance of a six-unit train by from 45 to 65 per cent. Full streamlining of the engine was not however attempted. As will be noted from our engraving the streamlining except at the front end is not carried below the centre line of the cylinders. Doubtlessly the question of accessibility entered into the design at this point but in a pamphlet issued by the builders we notice that the sole reason given for adopting less than 100 per cent. streamlining is a purely sentimental one. "No one," it is stated, "had the heart to cover up the life-giving elements of the locomotive. No savings in power would compensate for the loss of that thrill that the spectator gets from a steam locomotive at speed."

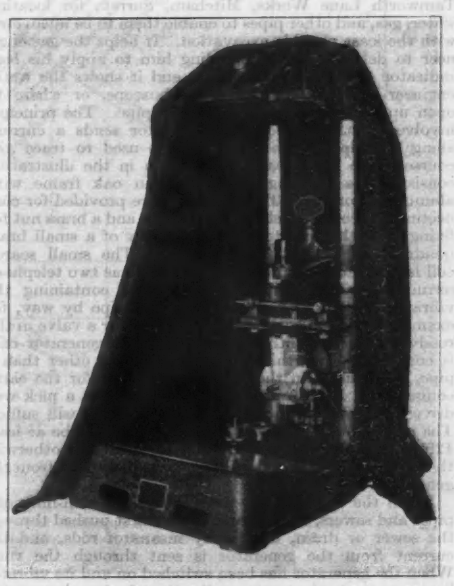
The engine has when loaded a weight of 280,000 lb. and the tender 247,500 lb. The cylinders measure 19in. by 28in. and the boiler pressure is 300 lb. per square inch. The total heating surface is 3245 square feet plus 1029 square feet in the superheater. The grate area is 69 square feet. The maximum tractive effort is given as 30,700 lb. The engine is scheduled to perform the journey of 410 miles in 390 minutes, including five intermediate stops, or at an average speed of 66 miles an hour. Five reasons are given by the builders for the adoption of steam in preference to oil-electric or electric systems. With steam, they say, they can most easily and economically secure all the speed that any railway will dare use for many years to come. The required horse-power can be obtained at a quarter of the initial cost of any alternative. The full output of the engine is available at or near the cruising speed. The surplus power obtainable with steam gives a flexibility which enables the number of coaches to be increased when the demand arises. Finally the steam engine is a form of power unit which can be maintained and operated with existing railway facilities and organisation.



STREAMLINED LOCOMOTIVE

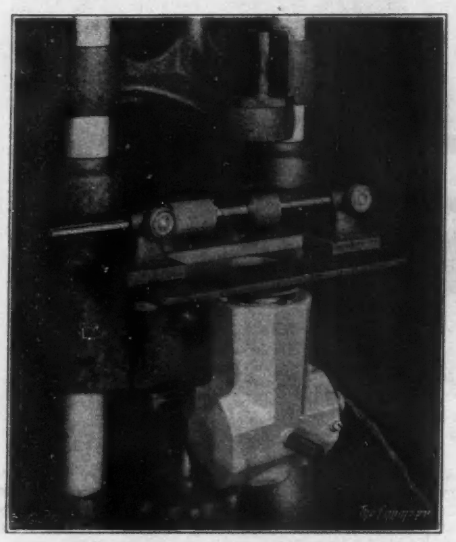
A Contour Projector.

THE instrument illustrated by the accompanying engravings is a very neat and compact contour projector, made by the Franklin Caster Company, of Great Charles-street, Birmingham. It occupies a bench space of only 24in. by 20in., and is 36in. high. As it weighs only 80 lb., it is easily transportable, and being provided with a light-excluding curtain it can be used in any convenient situation in the shops. Much of the general design will be made clear by the engravings. The table, which can be moved up and down vertically for focussing purposes by a screw, is carried on the main columns and two centres for carrying cylindrical work up to 3in. diameter and 5in. long can be arranged upon it. The projection lamp and condenser unit is arranged immediately beneath the work table. Three collar screws support the lamp and by their use it can be centred. Ample vents are left for the entrance of cool air into the lamp house. For the escape of the heated air there are a number of light-excluding vanes around the condenser lenses at the top of the casing.



CONTOUR PROJECTOR

The lamp is fixed by a bracket to a swinging rod hinged at the back of the table support, and this arrangement, in the case of screw threads, allows the whole lighting system to be moved normal to the helix of the thread to be projected. Above the work table the projection lens holder is carried by a bracket from the columns. Experience has shown that magnifications of ×10 and ×25 are sufficient for all purposes, the latter being required for particularly fine work. Two "Cooke" lenses to give these magnifications are therefore provided, the former having a field of 1¼in. and the latter a field of ⅝in. The lens holder is so made that one lens can be easily lifted out and replaced by the other. At the same time that this substitution is made, it is necessary also to change the condenser lens. The latter is also easily changed. In order to keep the instrument compact, the beam projected upwards is reflected by a mirror and focussed upon a screen, 15in. by 10in., of specially prepared plywood on the base of the instrument. Naturally, great attention has been given to the making of these mirrors, since it is



THE WORK TABLE, LAMP-HOUSE AND LENS

of the greatest importance that the accuracy of the instrument shall not be nullified by a distorted reflection. The mirrors are silvered on the outside and the resulting surface is protected by a transparent varnish. For use with the instrument the firm supplies a number of plates, giving the standard screw thread forms magnified ×25, so that checking of screws may rapidly be carried out. The makers claim that it is a utility instrument, and that it is not intended merely for laboratory use.

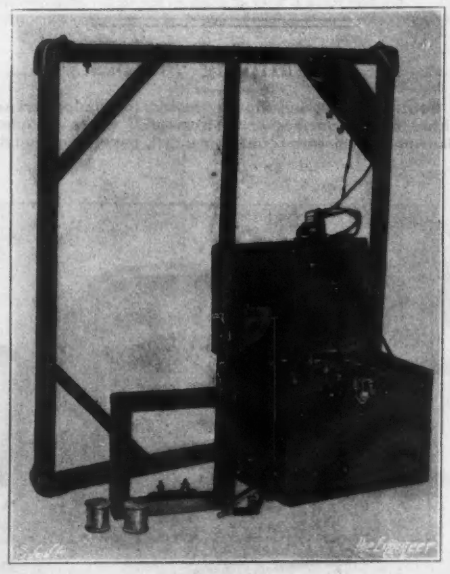
A Main and Service Pipe Finder.

THE apparatus shown in the accompanying illustration has been introduced by Price and Belsham, Ltd., of Tamworth Lane Works, Mitcham, Surrey, for locating water, gas, and other pipes to enable them to be uncovered with the least possible excavation. It helps the gas engineer to detect leaks by enabling him to apply his leak indicator exactly over the pipe, and it shows the water engineer where to apply his stethoscope, or where to open up the ground to test a leaky pipe. The principle involved is that an electric generator sends a current along the pipe and a search coil is used to trace the course. The large search coil shown in the illustration consists of a winding encased in an oak frame with aluminium corners. Two terminals are provided for connecting the coil to a telephone receiver and a brass nut for fixing a depth indicator, which consists of a small brass quadrant with a swinging pointer. The small search coil is also enclosed in an oak case, and has two telephone terminals. One terminal on the case containing the vibrator generator is connected to the pipe by way, for example, of a stop cock, a tap in a house, or a valve in the roadway, whilst another terminal on the generator case is connected to earth. Anything metallic, other than a pipe, well buried in the ground, will serve for the earth connection. An iron spike is often used, but a pick well driven into the ground or an iron gully gate will suffice. The generator and the earth connection must be at least 12ft. from the pipe it is desired to locate, as otherwise the operator may be misled by sounds picked up from the generator.

When the apparatus is used for tracing non-magnetic pipes and sewers, an insulated wire is first pushed through the sewer or drain, usually by means of rods, and the current from the generator is sent through the wire. When the generator has been switched on and its vibrator begins to work, the tester applies the telephone associated with the large search coil to his ear, and with the coil in hand moves about in the suspected vicinity of the pipe until he hears a tapping sound in the receiver, and then continues to alter his position until a spot is found at which the sound is loudest, when the pipe is exactly under the coil and in line with it. The course of the pipe can then readily be followed, for any deviation from the pipe results in a decrease in the sound. To locate the pipe more precisely at certain points, the coil is held flat, when the sound will be heard on either side of the pipe, but when it is directly over it there is dead silence.

To find the depth of the pipe, the depth indicator is attached to the search coil by means of the brass nut, so that when the coil is vertical the pointer swings freely and points to zero. The exact position of the pipe is then found and the search coil placed 4ft. 6in. to one side of the pipe and parallel with it. Next the coil is slowly tilted upwards until no sound is heard in the telephone, when the indicator finger points to the depth of the pipe in feet.

The small coil offers the advantage that it can be used where space is limited, and although less sensitive than the large coil, its indications are rather more precise, and it may prove preferable for certain purposes, such as that of unravelling a mass of pipes. Although electric

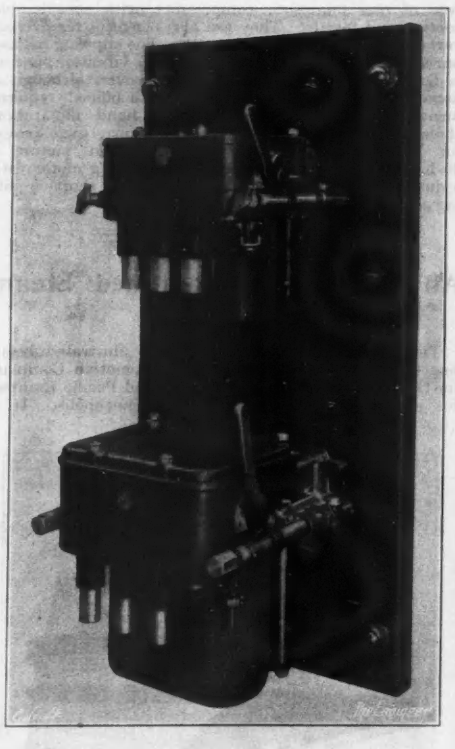


SEARCH COIL PIPE FINDER

light and power mains may cause the apparatus to pick up sounds, they are easily distinguishable from the tapping sounds of the mains finder.

Industrial Oil Circuit Breakers.

FOR industrial control on electrical systems working at pressures up to 600 volts, Ferguson, Pailin, of Higher Openshaw, Manchester, have introduced a range of oil circuit breakers designed to comply in all respects with the Factory and Home Office Regulations. As they are intended mainly for factory service, they are constructed to withstand rough usage, and the range includes oil breakers for "direct-on" starting, in addition to breakers



OIL CIRCUIT BREAKERS

used in conjunction with rotor starters for the control of slip-ring motors. The equipments are supplied suitable for floor, wall, or switchboard mounting, and can be provided with draw-out or non-draw-out features. Boards can be built up with equipments of varying current capacities, and owing to their compactness the breakers lend themselves to mounting schemes in places where space is limited. They may be mounted, for example, in vertical tiers, as shown in the accompanying illustration, either on new switchboards, or on any flat surface to replace obsolete apparatus, whilst additional saving of space may be effected by mounting the units back to back.

The standard ratings range from 60 ampères capacity up to 800 ampères or higher, while by the provision of suitable overload coils the smaller units may be used down to 5 ampères or lower. The welded steel form of construction has been adopted, the operating mechanism being of the true free-handle type, giving a high speed of break and having a minimum number of parts, adequately protected against undue mechanical stresses. All working parts have been made rustproof by "parkerizing." Easily removable arcing contacts are fitted to all the breakers, whilst on units rated up to 150 ampères each contact is reversible, a feature which doubles the contact life. Breakers rated above 150 ampères have high-pressure line contacts, giving a low temperature rise at the continuous rating. All the breakers are adequately interlocked, and a special feature of the draw-out units is the provision of double isolation, which increases the degree of the operator's safety. The tripping plunger is flush-mounted to obviate inadvertent tripping. To facilitate making the terminal connections and changing the trip coils, the top half of the switch carriage may be completely removed with ease. The usual number of protective releases can be provided. Inverse time delay on the overload plungers is provided by an oil dashpot, and all settings are visible and may be adjusted from outside the oil container.

American Engineering News.

Erosion Below Large Dams.

IN large overflow dams there is liability of serious erosion of the river bed below the dam, owing to the velocity and the impact effect of the falling water. Various methods have been tried to reduce or eliminate the destructive effects, and a study of such methods has been made recently by the United States Bureau of Reclamation, which has a number of large dams within its jurisdiction. A stepped surface for the downstream side of the dam, and the placing of baffles on the apron below the dam have been tried in many cases, but not always with satisfactory or expected results, owing to the difficulty of determining the action of the falling water in individual cases. Much valuable information in this respect has been developed by tests of models. Such tests are responsible for successful results with a stepped face on the 160ft. Gilboa Dam of the New York waterworks system. Another method is to provide a stilling pool at the foot of the dam by means of a secondary dam or weir, over which there will be a relatively smooth flow. In a number of cases, however, the downstream side of the dam is continued as an apron for a considerable distance below the toe of the slope. This apron is sometimes horizontal, but more usually it is concave, rising towards the lower end in such a way as to divert the flowing water upward as it leaves the apron. Baffles, in the form of concrete blocks or projections, as integral parts of the concrete structure, are sometimes placed on the apron or the downstream slope of the dam to break up the stream, but are expensive on account of the stability required to resist the heavy impact. In any design, the aim is to cause a hydraulic jump in which the energy of the flowing water is sufficiently dissipated to leave little for the formation of whirls and eddies, the flow beyond the "jump" being then so smooth and relatively slow as to cause but little scour or erosion of the river bed.

Large Suction Dredges.

Two large hydraulic or suction dredges have been added to the fleet operating on the southern part of the Mississippi River to maintain a channel through the shifting bars and shoals. The suction head is of the so-called "dust-pan" type, a shallow flat inverted box, 32ft. wide and 12ft. long, fore and aft. A partition divides it into two compartments 16ft. wide, each connected to a 26in. suction pipe. These two parallel pipes are, in turn, connected to a transverse hinged pipe, turning in bearings and carrying the end of the 34in. pump suction. The suction head is attached to tackle from an overhead frame carried by two steel towers on either side of the dredging well. The hull is 245ft. long, 52ft. beam, and 9ft. deep, with a draught of about 7ft. At the bow is the open dredging well, 60ft. long and about 38ft. wide. The main deck house is 140ft. by 41ft., with pump, engine, and boiler-rooms. Above it is the cabin, 140ft. by 23ft., with officers' and engineers' quarters, crews' quarters, messrooms and galley. Above the forward end of this is a house with the captain's rooms, surmounted by the pilot house, 8ft. long and 23ft. wide. For dredging, a turbine of 2100 h.p. at 3600 revolutions is geared to a pump with 6½ft. impeller, 34in. suction, and 32in. discharge, the material being delivered on either side or at the stern, as required. Two vertical marine triple-expansion engines of 1000 h.p. at 190 revolutions drive twin screws of 7ft. 3in. diameter in tunnels. These engines are at the stern and near the sides of the hull. The water jets at the suction head are served by a centrifugal pump with turbine. Steam at 350 lb. pressure is supplied by four oil-fired water-tube boilers, in two batteries, each with its uptake and funnel. Induced draught fans are driven through gearing by turbines. A steel spud or pile to hold the vessel in position works in a well just aft of the dredging well and just forward of the deck house. The steel hull is divided into thirty-three water-tight compartments, some of which are used as trimming tanks and for the storage of fuel oil and feed water.

DURING the coming summer season the Canadian Department of Mines proposes to send out no less than 180 surveying parties to examine and report on mineral areas, concentrating upon those believed to hold out prospects for the discovery of gold. It is estimated that the field costs for each party would average 4000 dollars, in addition to which there would be charges in connection with the preparation of reports and maps, the total expenditure anticipated being about 1,000,000 dollars. The parties will be in charge of trained geologists, and their work will be entirely investigational and not for the purpose of trying to locate and stake economic deposits.

"Noise." *

INTRODUCTION.

THIS paper must be regarded only as an index to the engineering aspects of an enormous subject. The great importance now attached to silence probably arises from a natural dislike of noise, given expression by insistence on its harm to the human organism. Except in the case of sleep disturbance of sick or neurotic persons, this harm is probably exaggerated as a rule. Experiments on typists, weavers, and Cambridge undergraduates have shown that the effects of moderately noisy surroundings on quantity or quality of work are only of the 5 per cent. order (1). Furthermore, no additional nervous strain is detectable in such cases. Excluding "boiler-makers' disease," &c., the greatest disadvantage of noise to normally healthy people is most likely to be its interference with conversation.

"Noise" should only be defined for the present purpose as "unwanted sound" (1) (2).

The physical or "objective" theory of sound and acoustic technique are now very highly developed, but psycho-physiologically (or "subjectively"), knowledge is much less complete, as will clearly appear later.

Not much machine silencing has been achieved yet, though the investigator has considerable equipment at his disposal. But the art is still probably in the condition in which a great deal can be achieved by inspired reasoning from simple experiment.

THE PHYSICAL NATURE OF SOUND.

It is essential to remember that the sensation of sound is due to fluctuations of air pressure of the order of one-millionth of an atmosphere repeated rapidly—that is, between about 16 and 20,000 times a second. Slower or faster pressure variations, however great, have no effect on the ear.

It must also be remembered that these pressure variations are propagated by *longitudinal* waves of the kind which occur in any elastic medium immediately any part of it is disturbed, and further, that the conventional "sine-curve" graph is completely misleading as a clue to their mechanism. The following elementary properties of sound waves are recapitulated here because of their special relevance :—

(1) As a longitudinal pure tone wave traverses a medium, each particle executes a simple-harmonic vibration in the direction of wave travel, but its mean position does not move forward.

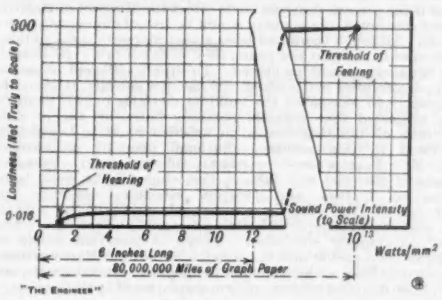


FIG. 1

(2) The following inter-related quantities go to the specification of a pure tone wave :—

(*a*) The frequency of vibration (of any one particle).
(*b*) The amplitude of displacement of a particle.
(*c*) The velocity of the particle.
(*d*) The instantaneous increase or decrease of pressure from the mean.
(*e*) The "power intensity" of the wave, or the rate of flow of energy past a given area.

(3) Sound pressure, particle velocity, and particle displacement vary inversely as distance from a point source or from the centre of the sphere equivalent to an actual source; power intensity varies inversely as the square of that distance.

(4) All complex sounds which repeat themselves accurately each cycle can be split up into the sum of a number of pure tones or "sine functions" (application of Fourier's theorem).

(5) Sound waves are reflected at boundaries or discontinuities in a medium, such as at the open end of a pipe for instance. The invariable result of such reflection is the production in enclosed spaces of "standing waves" or resonant vibrations.

SCALES OF MEASUREMENT : PHYSICAL.

The quantities which go to specify a sound are generally expressed as follows :—

(1) *Frequency.*—Expressed in cycles per second and ranging between about 16 and 20,000.

(2) *Sound Pressure.*—Generally expressed as maximum root-mean-square amplitudes of variation, in dynes per square centimetre, and ranging between 10^{-4} and 10^{+3}. In this paper, actual, instead of root-mean-square, maximum values are employed.

(3) *Sound Power Intensity, or Mean Energy Flow per Unit Area.*—Generally expressed in watts per square centimetre, and ranging between 10^{-16} and 10^{-3}, but in this paper as watts per square megametre, a quantity 10^{16} times smaller.

(4) *Sound Particle Velocity and Particle Displacement.*—These are not generally used, but can be expressed in centimetres per second and centimetres, in which they range respectively between 10^{-8} and 10^{+1}, and between about 10^{-9} and 10^{-4}.

(5) *Loudness.*—This is still expressed according to the expressor's own taste. Being a subjective quantity, it is dealt with later.

The great difficulty in all sound measurements is the terrific range of quantities involved, making ordinary arithmetical units clumsy and inconvenient. This is well brought out by Fig. 1, which shows, semi-diagrammatically, the *form* of the relation of loudness to sound power when both the quietest and loudest sounds which the ear can deal with are included. In consequence, the practice has arisen of taking a datum level and expressing a quantity in "Bels" by the logarithm of the ratio between the quantity and its datum.† In other words, every increase of ten times from the datum is said to raise the level 1 bel. To make the unit more practical, 1 bel is divided into 10 "Decibels." Whence, the difference in "level" between two quantities X_1 and X_0 is given in decibels by :

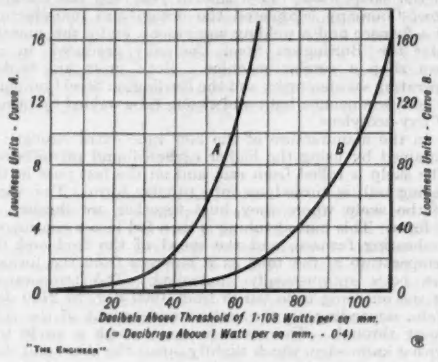


FIG. 2

$$d\,b = 10 \times \log_{10} \frac{X_1}{X_0}.$$

The decibel unit, having been used for many purposes for which it was never originally intended, is become controversial and misleading.‡ (3) (4). When quantities in this paper are expressed logarithmically, their ratios to each other or unity are given in "Decibrigs," this unit being defined simply as a number, in the same way as the decibel.§ Thus :

$$\text{Decibrig value} = 10 \times \log_{10} \frac{X_1}{X_0}.$$

(1 Decibrig $\frac{10}{\sqrt{10}}$, or 1·259.)

The interpretation of logarithmic expression should be noted; "20 decibrigs above . . ." or "20 decibrigs more than . . ." is equivalent to "one hundred *times* . . ." &c.

The only quantity which is expressed logarithmically in this paper is sound power intensity, which is used in preference to sound pressure for the specification of the physical magnitude of a sound. The magnitude of a sound in power intensity is given (for reasons which will be obvious later) in decibrigs more than a datum of 1 watt per square megametre. That is to say, 1 watt per square centimetre divided by 10^{16}, a "megametre" being taken as a million metres. It must be pointed out that all values given here are, except when otherwise stated, those of the sound itself in free space, and not the corresponding values created in the ear canal or anywhere else. It may also be noted that the power intensity value of a sound in decibrigs more than unity is substantially equal to one version of its decibel value.‖

It is important to remember that since sound power intensity is proportional to the square of sound pressure or particle velocity, a given change in the value of the power intensity expressed in decibrigs only causes half that change in pressure decibrigs. Thus, the human ear from minimum to maximum audibility covers a range of about 130 decibrigs in power intensity, but 65 decibrigs in pressure.

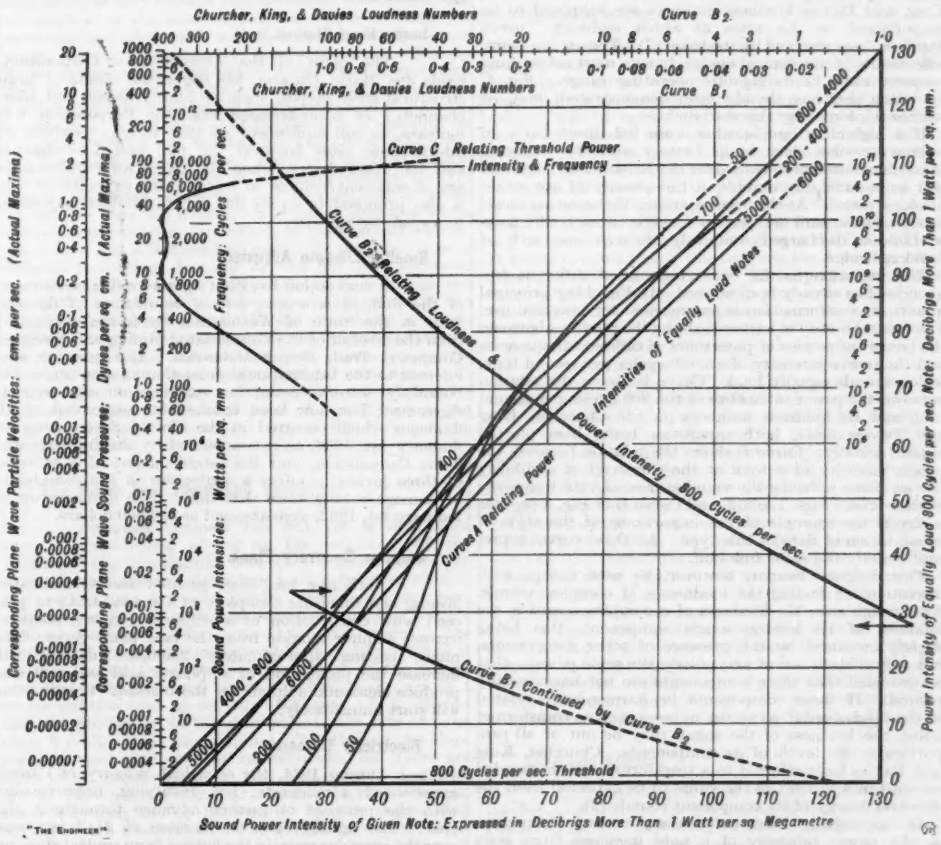
SCALES OF MEASUREMENT : SUBJECTIVE.

The subjective magnitude of a sound is its "loudness," and the specification of this quantity is probably the most difficult problem of the whole subject, being still only partially solved.

First, none of the physical quantities—pressure, particle velocity, power intensity, &c.—define the loudness of a sound. For a given value of one of these quantities, every different kind of sound has a different loudness. However, the first simplification is provided by the important fact that the loudness of any sound can be empirically recorded for reference by specifying the physical properties of some easily reproducible pure tone *which sounds equally loud*. Thus, the value of a given reference tone in power intensity or sound pressure units may be noted, at which its loudness sounds equal to that of the sound under investigation. Whence, any noise may be specified as having the same loudness as an 800-cycles per second pure tone, with a power intensity of dbg. decibrigs more than 1 watt per square megametre. Reference tones of 500 to 1000 cycles per second have been employed, but there is some evidence in favour of 800 cycles per second.

Secondly, although all noises can be reduced, as by the foregoing, to the same reference figures, the question of their "loudnesses" is still unsettled. The difficulty here is that "loudness" is human sensation and nothing but an *idea*. The problem of measuring the loudness of a sound in figures is exactly equivalent to that of measuring the smelliness of a drain or the boringness of a discourse.

Until recently, measurement of loudness has been based on two psycho-physiological laws. The Weber law states that for all sense organs—touch, sight, hearing, &c.—a definite geometrical or fractional increase of stimulus is necessary to produce the minimum perceptible difference in sensation; that is to say, for the change to be noticeable. This law was generalised by Fechner into a statement that human sensation is proportional to the logarithm of a physical stimulus in the appropriate units. Accordingly, until a few years ago, it was generally believed that the loudness of a sound is proportional to a physical magnitude logarithmically expressed in decibels above a datum. This view is still held in some quarters, but there is evidence to the effect that loudness varies more nearly as the fourth or fifth power of its decibel value, while the Weber and Fechner laws are now considered by physio-


Churcher, King, & Davies Loudness Numbers
Curve B_2
Churcher, King, & Davies Loudness Numbers
Curve B_1
Curve C Relating Threshold Power Intensity & Frequency
Curve B Relating Loudness & Power Intensity 800 Cycles per sec.
Curves A Relating Power Intensities of Equally Loud Notes
Curve B_1 Continued by Curve B_2
800 Cycles per sec. Threshold
800 - 4000
800 - 400
6000
50
100
200
400
1000
2000
5000
Corresponding Plane Wave Particle Velocities: cms. per sec. (Actual Maxima)
Corresponding Plane Wave Sound Pressures: Dynes per sq. cm. (Actual Maxima)
Frequency: Cycles per sec.
Sound Power Intensities: Watts per sq. mm
Power Intensity of Equally Loud 800 Cycles per sec. Note: Decibrigs More Than 1 Watt per sq. mm.
Sound Power Intensity of Given Note: Expressed in Decibrigs More Than 1 Watt per sq. Megametre
"THE ENGINEER"

NOTE.—*The Curves "A" Refer to the Lower Horizontal Axis and the Right-Hand Vertical Axis. The Curves "B" Refer to the Right-Hand Vertical Axis and the Upper Horizontal Axis. The Curve "C" Refers to the Left-Hand Vertical Axis and the Lower Horizontal Axis.*

FIG. 3

* Abstract of a paper read on October 22nd, 1934, before the Graduates' Section of the Institution of Mechanical Engineers by A. C. Hutchinson, B.Sc. Hons. (Lond.).

The full text comprises a bibliography, prepared by Mr. H. Davies, M.Eng., in place of which the most important references are here given as notes to the text.

† Initiated by the Bell Telephone Laboratories of America, the unit being named after Alexander Graham Bell.

‡ See also Appendix B.

§ Proposed by A. H. Davis, D.Sc. (8).

‖ That of Churcher, King and Davies for an 800 cycles per sec. note.

logists to hold only over very narrow ranges (2), (3), (4).

The new method of estimating loudness is that of "fractional estimates." There have been several investigations by this method, but the only one so far carried out in this country is that performed with great refinement of detail in the research laboratories of the Metropolitan Vickers Electrical Company, and described by Messrs. Churcher, King, and Davies in a paper read before the Institution of Electrical Engineers on March 8th, 1934 (2).

The procedure consisted in supplying each of a subject's two ears with a pure tone of 800 cycles per second from a headphone. The subject then adjusted the power intensity of one tone until it seemed to him to be *half as loud* as the other, the respective physical power intensities of the two sounds being then noted. Starting with a datum power intensity of "100 decibels above threshold" (equal to 100·4 decibrigs more than 1 watt per square megametre), which was called "100 loudness numbers," the physical magnitudes associated with loudness numbers of 50, 25, 12·5, 6·25, 3·125, and 1·5625 were determined by thirty unskilled and four skilled observers, and the relation shown in Fig. 2 obtained. These values were checked by further experiments after an interval of six months and with another frequency and by estimates of "*one-quarter as loud*." In fact, it would appear, however unlikely that may seem, that there is something psychologically absolute about the mental estimate of *N times as loud*.

With regard to other investigations of loudness by this "introspective" method, it is stated by Churcher and King that four out of the five published are concordant with one another (4). It must be remembered, however, that investigations of this kind are of unusual difficulty, and that results will never probably be established as certainly as are the properties of steam, for instance. Further, in reviewing evidence, the method by which it was obtained must be scrutinised in detail. For example, an impressive research, in which a total of 4500 readings were taken by 175 different observers, and the result obtained that the loudness of a sound is exactly proportional to the cube root of its power intensity, turns out, on closer inspection, to be empirical and unconvincing (5).

The Human Hearing System.

The most essential element of the organ of hearing is a gamut of about 4000 fibres, each tuned to vibrate in resonance to some frequency within the audible range of about 16 to 20,000 cycles per second. Appropriate fibres are set in vibration by incoming sounds, and, as the result of titillation of hair cell groups associated with those particular fibres, the brain is informed through the auditory nerve of both the frequency and magnitude of each component present in the sound (6). The Churcher, King, and Davies loudness numbers are supposed to be proportional to the rates at which auditory "nerve impulses" are received by the brain (7). The ear has many refinements of mechanical design, but its most astonishing property must be its gigantic operating range. Fig. 1, by which this has already been demonstrated, may be further reinforced by this statistic :—

If a high-class loud-speaker were fed direct from an ordinary pocket flash lamp battery and the resulting noise distributed uniformly over the British Isles, it would still be comfortably audible in the absence of any other masking sound. At the other extreme, the same ear could listen without pain or "*feeling*" to the entire traffic noise of London discharged uniformly through one arch of London Bridge.

The variation in the ear's response at different frequencies has already been noticed. In Fig. 3 the principal quantitative information is summarised for practical use. The central family of curves A shows the relations between the power intensities of pure tones of different frequencies and the power intensity of an 800-cycles per second tone, which sounds equally loud. Curve B shows the relation between the power intensities of the 800-cycles per second tone and its loudness numbers on the Churcher, King and Davies scale, both quantities being here plotted logarithmically. Curve C shows the relation between the power intensity of a tone at the threshold of audibility (for an observer facing the sound source) and the frequency of that tone. Figs. 1 and 2, and Curve B of Fig. 3 provide a significant example of the importance of the style of presentation of data of this type. All these curves represent exactly the same function.

This diagram cannot, however, be used except with discretion for finding the loudnesses of complex sounds. As a rough rule, the loudness of a complex sound is the loudness of its loudest single component, this being *slightly* increased by the presence of other components, but only if these are of very nearly the same power—that is, provided that these components are not harmonically related. If these components be harmonically related to the fundamental, as occurs in cases such as transformer noise, the loudness of the sound may be out of all proportion to the levels of its components. Churcher, King and Davies have referred to a transformer which sounded eleven times as loud as the value to be expected from the summed energy of its component sounds (2).

It has already been noted that, at each frequency, as the power intensity of a note increases from zero, it does not produce any audible effect on the ear until it reaches a given magnitude this being called the "threshold of audibility" for that sound, and having a different value for every type of sound.

One other property of the ear is practically important, that being the ability of one sound to mask another, or to render it inaudible. This has long been noticed practically. For instance, Wing Commander Cave-Browne-Cave has observed how, when the exhaust noise of a motor cycle has been effectively silenced, many other previously unnoticed noises have appeared (13). Masking has also been scientifically investigated at great length by the Bell Telephone Laboratories. Generally speaking, and contrary to what might be expected, a lower note easily masks a higher note, but a higher note has, relatively, to be very powerful before it can obliterate a lower note (6).

(To be continued.)

In a small aeroplane fitted with a 5 h.p. engine, Herr Kronfeld, the Austrian gliding expert, flew last week from Croydon to Paris in 4 h. 10 min.

Canadian Engineering News.

(By our Canadian Correspondent.)

Welded Rail Steel Tubing.

In the past few years the use of tubular steel products has been increasing rapidly. The Burlington Steel Company, Ltd., Hamilton, Ontario, has in the past been producing a tube rolled from rail steel and sold in butted form or in the form of a brazed tube. With the wider and increasing demand it became apparent that the old method of brazing the tube would not satisfactorily meet the needs of the enlarging market, and some two years ago, in conjunction with the Calumet Steel Company, of Chicago, a serious effort was made to produce a welded tube which would be as strong across the weld as the skelp itself. Less than a year ago the Calumet Steel Company completed the design and manufacture of a furnace and a welding equipment, and a few months later the Burlington Steel Company produced in its own shop a similar machine. Both units are to-day operating satisfactorily, and the Burlington Steel Company is now producing a light and strong tube welded by means of oxy-acetylene.

In the manufacture of the new tube extra strength is obtained by using the higher carbon found in rail steel. The skelp is rolled from rail, and on the last pass in the rolling mill is turned up into tubular form. The edges of the skelp where they butt together are finished in V form. This butted tubing is then fed into a continuous preheating furnace, and the speed of the feed and the temperature of the tube as it emerges from the furnace are both automatically controlled. The temperature of the outgoing tube varies from 1900 deg. to 2100 deg. Fah., depending on the section and weight of the tube going through. The seam passes through a guide tool with a knife edge, which slightly opens the joint, and then through guide rolls, which close it up again to the exact dimension required as it passes under the welding tips. The welding method might be termed a semi-puddling process, and success is obtained only by careful control of the preheat temperature, the speed of the machine, and the temperature of the oxy-acetylene flame. The tube then passes through re-forming rolls, and the finished material is turned out to very close tolerances.

Numerous tests of the finished product have been carried out, both in a practical way by testing to destruction under factory conditions, and in a theoretical way at Toronto University, and the strength of the weld shows in many cases well over 90,000 lb. to the square inch. The theoretical strength of rail steel according to standard specifications is 80,000 lb.

Large Steel Shapes.

The plant of the Algoma Steel Corporation, Sault Ste. Marie, Ontario, has begun the rolling of large structural steel shapes, such as 13in. I-beams and 15in. channels. It is understood that the Corporation will increase its roll equipment so that it may produce all intermediate sizes between the 6in. and 7in. channel and the 15in. shapes, when the Canadian requirements are of sufficient volume to warrant the expenditure. It is also proposed to equip the mill to produce angles up to an 8in. by 8in. size.

Smelter Dispute Adjusted.

A convention has been signed for final settlement of the difficulties arising out of complaints of damage done in the State of Washington by fumes discharged from the smelter of the Consolidated Mining and Smelting Company, Trail, British Columbia. The question was referred to the International Joint Commission under the boundary waters treaty for examination and report. Agreement has now been reached for settlement of all damages which occurred in the United States prior to January 1st, 1932, as recommended by the International Joint Commission, and the establishment of a tribunal of three jurists to effect a settlement of the complaints of damage arising since that date. The damages up to January 1st, 1932, were assessed at 350,000 dollars.

Sulphur Recovery Plant.

Authority has been granted the Consolidated Mining and Smelting Company of Canada, Ltd., to proceed with construction of a sulphur recovery plant to extract sulphur dioxide from the zinc plant gases. The plant, costing approximately 2,500,000 dollars, will increase the production of sulphuric acid and will also produce elemental sulphur for the market. Construction will start immediately.

Electricity Demand.

During 1934, the electrical industry in Canada experienced a moderate, but gratifying, improvement, with the prospect of further advance throughout this year. The figures show an increase of 21·2 per cent. over the previous year, in the output from central stations. The situation in Canada is particularly encouraging when a comparison is made with the United States, where latest figures show an increase of 7 per cent. over 1933 with consumption below the peak years of 1929 and 1930. The substantial increase in Canada is due in part to the sustained interest of Canadians in adding to the electrical equipment of their homes. There has also been a national growth and more extended use of practically every type of electrical equipment. Practical use of surplus power was the main objective of the electrical industry in 1934, and continues this year. With an abundance of developed and available power, central stations are confronted with the problem of utilising this power in the best possible manner. One great factor in the solution of the problem has been the use of electric steam generators to supply steam to industrials at costs competitive with those of steam generated by coal. As a result of this Canada now has electric steam generator installations of over 1,500,000 h.p. Another potential future use for off-peak power in Canada is found in the generating of oxygen and hydrogen electrolytically from water. The process has already been proved to be commercially practicable, and awaits only the development of commercial products or industrial process requiring one or both of these gases in quantity. Already a large installation of electrolytic cells has been in satisfactory operation in the fertiliser plant of the Consolidated Mining and Smelting Company at Trail, B.C., indicating the practicability of such equipment.

Civil Aviation.

The Canadian Department of National Defence has issued statistics showing a vigorous upturn in civil aviation activities in 1934 compared with the previous year. The figures show that Canadian civil aircraft flew 75,871 hours last year, an increase of more than 20,000 hours over 1933 figures, and almost 19,000 hours over 1932 flying. The planes flew 6,497,637 miles, carrying 105,306 passengers, 14,441,179 lb. of freight, and 625,000 lb. of mail, bringing the air mail weight *per capita* for the year to a higher point than in any other country in the world. The increase in the number of passengers flown was approximately 31,000 compared with 1933, and almost 40,000 compared with 1932. Freight flown, mostly in Northern mining areas, was 10 million pounds heavier than in 1933. The number of aircraft operators increased from 90 in 1933 to 128 in 1934, while the number of licensed aircraft rose from 345 to 368.

LAUNCHES AND TRIAL TRIPS.

Rothesay Castle, motor vessel; built by Harland and Wolff, Ltd., to the order of Union-Castle Mail Steamship Company, Ltd.; dimensions, 443ft. by 61ft. 5½in. by 36ft. 9in.; to carry cargo. Diesel engines of Harland-B. & W. type; constructed by the builders; launch, February 21st; handed over to owners after trial trip.

Explorer, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Charente Steamship Company; dimensions, 435ft. by 56ft. by 32ft.; to carry cargo and a few passengers. Steam engines, triple-expansion; constructed by the Wallsend Slipway and Engineering Company; launch, April 2nd; trial trip, May 16th.

Roslin Castle, motor vessel; built by Harland and Wolff, Ltd., to the order of Union-Castle Mail Steamship Company, Ltd.; dimensions, 443ft. by 61ft. 5½in. by 36ft. 9in.; to carry cargo. Diesel engines of Harland-B. & W. type; constructed by the builders; trial trip, recent.

National Building.—At a luncheon of the Society of Engineers on Friday, May 17th, Mr. A. C. Bossom spoke on the subject of introducing new methods of building in this country. He said that if the present progress made under the Minister of Health's plans continued, the country would be free of slums within five years. Although there had been a vast increase in the number of houses in the past few years, they were not of a type suitable for the average working classes. To supply sufficient houses at a moderate price and without the use of a subsidy, it would be necessary to reorganise the building methods of this country. He suggested that national planning based on the progress methods of building as used in America could be beneficially adopted in this country. National planning as outlined by Mr. Bossom was expedient, efficient, and eliminated waste of material and labour, the whole of the work being done to a time and progress schedule, carefully laid out before the work is commenced, and rigidly adhered to, whereby the supply of building material and rate of erection are continuously controlled. Prices of materials would be settled for a period and the scheme so laid out that construction would keep within the limit of output of raw materials, and would be designed to give uniform employment in all districts.

A New Saw Set.—From James Neill and Co., Ltd., Napier-street, Sheffield, we have received a sample of a new "Eclipse" product, a direct reading saw set. The saw is firmly gripped between an anvil and a plunger which is advanced towards the anvil by a movement of the handle. The area over which the gripping pressure is applied lies a short distance below the edge of the saw in order that the teeth may stand clear of the grip ready for bending. The actual setting is effected by a second and smaller plunger at the centre of the first which is advanced by the continued movement of the handle after the first plunger has come to rest. The working point of this second plunger is in the form of a thin blade with its leading edge cut at an angle. The anvil is a circular steel button with a bevelled face, the angle of the bevel being not quite the same as the angle at the end of the setting plunger or blade, with the result that the pressure is applied by the setting plunger to the tip of the saw teeth and not to the whole depth. This angular relief is claimed to avoid the breakage of the teeth. The bevel on the anvil while of a constant angle increases spirally round the face. The anvil is held by a locking screw and may be fixed at any angular setting. Its edge is graduated from 4 to 12, corresponding to saws with four to twelve teeth per inch. By this means the variable bevel can be adjusted to suit the variable amount of set required for the teeth of coarse and fine pitched saws. The tool is strongly made and well finished and a practical trial has satisfied us that it is easy to operate and efficient.

Sectional and Graph Papers.—Extensively as sectional and graph paper is employed by engineers, its use would probably be still greater if the most suitable form of paper for a particular purpose were available when it was required. It cannot be doubted that restriction, inconvenience and inaccuracy frequently arise as a result of the graph paper available being ruled unsuitably with respect to the statistical data to be plotted. Apart from the ruling the quality of the paper may be a source of trouble; it may be too flimsy, on one occasion, to meet the demand for preservation and, on another, it may be too stout and opaque to suit the requirements of blue print reproduction. It would be a bold claim for anyone to make that he was prepared to supply every form or type of sectional paper which may reasonably be demanded. Yet judging from some samples which we have received we would say that if any manufacturer of sectional and graph papers is in a position to make such a claim it must be Wightman Mountain Ltd., Artillery House, Victoria-street, S.W.1. A sample packet of graph sheets which the firm has sent us contains sixty-two different patterns, but from two sample books accompanying the packet we gather that many other patterns are also produced in various sizes, as rolls, loose sheets or in pads and on thick or thin paper or on tracing cloth. Besides ordinary square rulings, variously subdivided from fourths to twentieths of an inch and in centimetres subdivided to tenths, there are included a variety of profile and other differentially divided rulings, numerous forms of logarithmic rulings, periodical rulings for daily, monthly or yearly returns—some with plain and some with logarithmic rulings against the time base—circular, or polar, charts, triangular co-ordinate paper, isometric rulings and iso-candle co-ordinate paper. There are included in the selection even examples of "arithmetic probability" rulings. Certain of these papers have previously been obtainable only from foreign sources. It is satisfactory to know that they are now being produced in such a variety of patterns by a firm which has had over thirty years' experience in the production of sectional and graph papers.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Anglo-Continental Steel Negotiations.

Meetings between the British and Continental steel makers have taken place in London this week. These followed meetings between the various industries included in the Continental Cartel and also between the Cartel and the British steel makers held on the Continent last week. It is understood that the discussions in London have ranged over wire rods, plates, sections, strip and hoop, bars and semis. So far, according to report, they have been chiefly concerned with the Continental makers' quota of these descriptions of steel for the British market after the expiration of the three months' temporary arrangement on August 7th. It is stated that progress has been made towards reaching a long-term agreement, but there is still a considerable amount of work to be done, particularly in adjusting the British share of the export markets over a lengthy period. The loss of the British market naturally makes the Continental steel makers reluctant to circumscribe their export trade in favour of the British, and the potential development of the British steel industry under the protection of the duties makes a satisfactory adjustment difficult. In the meantime, new business in Continental steel in the British market has practically ceased. It is understood that the tonnage contracted for by the Cartel before the temporary arrangement was reached practically fills its quota for the three months. As a result, it has been difficult for British buyers to place orders for Continental steel, excepting with merchants who held contracts with the works, and these have been almost exhausted. According to reports from abroad, the Continent is also finding export business distinctly quiet, and some uneasiness is felt regarding purchases which have been made by countries in which currency instability has developed. One of the most interesting events on the Continent, however, has been the inclusion of the Polish works in the Wire Rod Cartel, from which they have held aloof for some years. It is suggested that this is merely a step towards their becoming parties to the International Rail Makers' Association (IRMA). In the past the independence of the Polish works has been a source of trouble to this Association and their inclusion in the agreement would be welcomed by the other members.

Iron and Steel Imports.

The Board of Trade Returns for April cover the first month in which duties of from 50 to 60 per cent. upon iron and steel were in force. Later, these were reduced to the previous level of 33⅓ per cent., but it is interesting to note their effect upon imports. Further interest attaches to the figures in view of the Anglo-Continental steel pact based upon the 1933 figures, and limiting the imports for the three months ending August 7th to 160,750 tons. The total imports of iron and steel in April were only 62,739 tons, about half the total for April last year, when the figures reached 125,324 tons and less than for the corresponding month in 1933, when the imports were 70,891 tons. Compared with the total for March of this year of 125,975 tons, there is a heavy reduction. Imports of pig iron in April dropped to 4150 tons, compared with 12,606 tons in March, but of the April total 2978 tons came from British India. The fall in the quantity of billets reaching this country is very noticeable, the total being 10,027 tons, compared with 22,954 tons in March. In the latter month 16,291 tons came from France, against 6254 tons in April, and 4386 tons from Belgium, compared with 3110 tons in April. The reduction in the imports of sheet bars was equally striking, as in March 12,285 tons came in, against 5294 tons in April. Although in March Belgium, Germany, Luxemburg, and France all sent sheet bars to this country, in April supplies came only from France and Belgium, the latter country sending 8911 tons in March and 4762 tons in April. Imports of girders, beams, joists, and pillars, which in March amounted to 6714 tons, fell in April to 3055 tons. Belgium appears to have been the chief sufferer from the decline, the imports from that country for March being 3996 tons, compared with 1655 tons in April. Taking the total import figures, however, Belgium was the largest supplier of all kinds of iron and steel, the figures for April reaching 25,077 tons, France being next with 12,101 tons, then Luxemburg with 5676 tons and Germany next with 4144 tons.

Export Trade in Iron and Steel.

There was a big jump in the exports of iron and steel in April, the total of all kinds reaching 210,880 tons, compared with 175,765 tons in March. For the four months ended April 30th the figures were 740,845 tons, compared with 642,464 tons for the corresponding period in 1934 and 572,101 tons in 1933. The exports of pig iron showed a notable increase in April to 18,596 tons from 7045 tons in March. Practically all markets took larger quantities than in the previous month, the exports to "other British countries" for March being 1260 tons and for April 3140 tons. The United States took 100 tons in March and 3568 tons in April, whilst exports to "other foreign countries" increased from 2809 tons to 5440 tons. General descriptions of steel showed a moderate increase from 14,732 tons in March to 15,861 tons in April, the largest buyer being British India with 2715 tons, South Africa coming next with 1495 tons. The total exports of girders, beams, joists, and pillars also improved to 3115 tons in April from 1412 tons in the previous month, but the exports of hoop and strip dropped from 4714 tons in March to 3210 tons in April. There was a sharp improvement in the export figures for plates and sheets, not under ¼in. thick, the March figure being 18,565 tons against 22,077 tons in April. Of this total, the Soviet Government took 6585 tons, compared with 2598 tons in March. The exports of plates and sheets under ¼in. thick improved to 12,098 tons against 11,137 tons in the previous month. As in March, the best customer was the Argentine Republic with 4109 tons, the March total being 4679 tons. Exports of galvanised sheets increased from 24,285 tons to 28,263 tons, and 29,326 tons of tin-plates were sent abroad, compared with 23,840 tons in the previous month. There was little difference in the export figures for tubes, the tonnage for March being 13,757 and for April 13,233. Exports of railway material, however, improved from 11,299 tons in March to 14,208 tons in April. Of the April total 4897 tons represented new steel rails, 2859 tons tires and axles, and 3712 tons railway axles and axles complete. British India took the largest quantities in April, the figures being 22,238 tons, Canada came next with 17,203 tons, South Africa being a close third with 17,015 tons. Russia was the best foreign customer last month and took 14,975 tons, Denmark coming second with 13,643 tons.

The Pig Iron Market.

The improvement noticed last week in the pig iron market has continued, and although there are still some weak spots the tone is more cheerful than for many weeks past. The tendency for consumers to confine their purchases to prompt parcels is still noticeable; but the turnover has improved and the weight of individual orders has increased. Inquiries are in circulation which suggest that contracts which will expire during the next few weeks are likely to be renewed, and that in some cases larger tonnages will be required. The demand for foundry pig iron on the North-East Coast has strengthened, and the light castings makers are taking good supplies, whilst larger quantities are being sent to Scotland. The limited output of foundry iron in this district is absorbed without difficulty, and in a few instances consumers have bought Northamptonshire foundry iron. The home demand is strong enough to make the producers independent of export trade, although occasionally business has been transacted with old-established connections in foreign markets in which the makers desire to retain a footing. The situation in the Midland iron markets has been improved by the stronger demand from the light castings foundries. Buying, however, has been largely confined to near-by dates, and consumers generally show little inclination to enter into forward commitments. The belief that an increase in the price of foundry iron is unlikely has naturally had much to do with this attitude on the part of users. Some of the contracts now in hand are not likely to be worked off by the end of June, when they expire, and this influences consumers against buying forward. Conditions in the Scottish pig iron market continue almost unchanged. A fair amount of English iron is reaching the consuming works, but this has not had much effect upon the demand for local makes. Possibly Cleveland makers are feeling the competition of Northamptonshire foundry iron in Scotland, since this can be obtained at about 1s. 3d. less than the former. Business in hematite keeps up well and deliveries, particularly in the Sheffield district, have been on a substantial scale. Export business is difficult to arrange, but one or two fair-sized contracts have been placed lately. The stocks of hematite on the North-West Coast are not heavy, and at some of the works are less than normal. On the other hand, overseas inquiries have become scarce of late, particularly from the Continent, and transactions with consumers in the United States have been intermittent for some time. It is interesting to note that in April 11,094 tons of foundry iron were exported, out of a total of 18,596 tons of pig iron, but probably the export figures for May will be considerably less.

The North-East Coast and Yorkshire.

Although business has not yet settled down from the disturbing effects of the reduction of the tariff, and the negotiations between the British and Continental steel makers, there has been a brighter tone in the market than for some weeks. Consumers and merchants have placed orders with some freedom, but forward business has been chiefly confined to small parcels. The North-East Coast makers have shared in this revival in demand during the past week, and most of the works, now that they have new orders on their books, are in a better position than at any time this year. It is claimed that the production in this district is at the rate of more than 2 million tons per annum. The demand for shipbuilding steel continues to be restricted, but there are signs of an improvement in this department. Inquiries are in circulation for a fair amount of new tonnage, some of which should be secured by the shipbuilders on the North-East Coast. The shipyards on the Wear and the Tees are rather poorly employed, although some of them have a fair amount of repair work in hand; but on the Tyne the builders are better situated. Orders from the railway companies now on the steel producers' books represent a considerable tonnage, and there seems a prospect that fresh business will mature in this department. The sheet works also have improved their position recently, although this branch of the industry is suffering from the poor overseas trade. The plate mills are moderately busy, and there is a heavy production of semi-finished steel in the shape of billets and sheet bars. The situation in the Sheffield steel market is generally satisfactory. The demand is principally for basic steel and a heavy tonnage is being turned out. The works producing tires and axles are busy on important orders for the railways, and recently contracts for other railway requirements have been placed in the district. The re-rolling mills are well employed, but did not secure the volume of orders they anticipated during the period of high duties. A considerable business is passing in aircraft steel. The sheet mills are not so actively employed as they might be, with the exception of those producing stainless steel sheets, the demand for which shows no signs of relaxing.

Current Business.

An order for new boiler plant comprising three 30,000 lb. to 45,000 lb. per hour boilers fired by chain-grate stokers, and working at 315 lb. per square inch, has been placed by John Walker and Co., of Greenock, with Simon-Carves, Ltd., of Cheadle Heath. Tangyes, Ltd., Cornwall Works, Birmingham, have secured an order for a 3250-ton hydraulic press for constructional steelwork. The Birmingham Electric Furnaces, Ltd., have acquired the sole rights in the British Isles for the Lindberg regulator. Hitherto this instrument has been supplied by the Lindberg Steel Treating Company, of Chicago, but will now be made and sold in England under the name of "Birlec-Lindberg" controller. T. and J. Harrison, Ltd., steamship owners, of Liverpool, have purchased four steamers from Furness, Withy and Co., Ltd., for, it is understood, £123,000. A plant for the manufacture of hydrochloric acid has been despatched by the Thermal Syndicate, Ltd., of Wallsend, to Japan. The Department of Overseas Trade reports that the following contracts are open for tender:—India Stores Department: Metallic body fittings for railway carriages, including louvres, ventilators, cocks, valves, brass and steel hinges, galvanised tanks, cotters, lock nuts, window catches, locks, wash-hand basins, flushing cisterns, &c. (Simla, July 1st). Eastern Bengal Railway: Locomotives and boilers (India, June 24th). South Africa: Johannesburg City Council: Three petrol-driven tower wagons, three motor ambulances (Johannesburg, June 8th); South African Railways and Harbours: Cold drawn weldless steel boiler and superheater flue tubes, arch tubes and steel boiler tubes with copper ends, required in 1936 (Johannesburg, June 17th); vacuum brake (metal parts), (Johannesburg, June 24th); one 20-ton solid rubber-tired road trailer, fifty 5–6-ton four-wheeled welded frame road trailers, fifty 5–6-ton four-wheeled welded frame road trailers (Johannesburg, July 8th). New Zealand, Posts and Telegraphs Department: 300 copper earth plates (Wellington, July 23rd); 50,000 galvanised insulator spindles and 12,000 galvanised steel swan-neck bolts (Wellington, July 26th); 75 tons hard-drawn copper wire, 200 lbs. per mile (Wellington, July 18th).

Copper and Tin.

A further improvement has taken place in the copper market over this week, and anticipations of a reaction in prices have not been fulfilled. Consumers seem to have realised at last that the producers' restriction scheme will be carried out according to plan, and there has been a steady volume of buying from practically all markets. The producers have shown a reluctance to sell forward at times and merchants have not found it easy to obtain all the copper they required. After some years of depression this market seems to have turned the corner, and the view is expressed that the European quotation will be raised to the level of 9 c. ruling in the United States. It seems possible that if this happens the American official price also will be advanced. It is, perhaps, fortunate that the heavy sales by American producers in the London standard market during the past six months have resulted in the accumulation of substantial stocks of electrolytic copper in this country. Some of this metal has been taken out of warehouse and sold to consumers, and it seems probable that more will follow. The buoyant tone of the London standard copper market has been maintained, and although there has been a considerable amount of profit taking, this was absorbed by merchants who were unable to obtain all the electrolytic copper they required from the producers. Some of the buying in this market is attributed to investments by Continental interests as a hedge against currency depreciation. . . . The "squeeze" in the tin market is being continued, in spite of the resentment felt by dealers. So far there has been no indication that the Buffer Tin Pool intends to use its stocks to relieve the tight position. A backwardation now exists of £7, and there is a tendency for this margin to increase. A meeting of the International Tin Committee is to be held on June 12th, and it is suggested that an alteration in the policy of the control will then be made; but this seems a doubtful prospect. American buying has been rather more in evidence recently, but Continental consumers, although they are said to be short of stocks, have not abandoned their policy of buying from hand to mouth.

Lead and Spelter.

Firm conditions continue to rule in the lead market, and there is no slackening in the activity which has ruled for the past week or two. Lately the position has been strengthened by a considerable volume of buying from the Continent. Some of this no doubt is for industrial purposes, but a proportion of it is the result of a lack of confidence in some of the gold currencies. As a result of recent purchases by Germany and other Continental countries, a certain amount of lead has been diverted from the London market, and the supplies for this month will be on a smaller scale than usual. It is scarcely likely, however, that a shortage will develop, as it is known that the producers hold large stocks in various parts of the world, the figure for this country being 18,600 tons. It is reported that negotiations regarding the change in the present import duty between the various interests concerned are making satisfactory progress, and that an agreed scheme will shortly be referred to the Import Duties Advisory Committee. . . . There has been an active industrial demand for spelter, and at the same time "bear" covering has helped to strengthen the market. Prices have advanced sharply under the influence of this buying, and the appearance of this market has greatly improved. Arrivals of Mexican spelter which usually go into bonded warehouse are likely to be less this month, as a considerable tonnage will be sent to Germany in satisfaction of sales made a week or two ago.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow	
	4 0 6 „ Sheffield	
	4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 17 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.
Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9¾d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, May 22nd.

Copper—		
Cash	£33 18 9 to £34 0 0	
Three months	£34 6 3 to £34 7 6	
Electrolytic	£37 0 0 to £37 15 0	
Best Selected Ingots, d/d Birmingham	£37 10 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
Tin—		
Cash	£229 5 0 to £229 15 0	
Three months	£222 12 6 to £222 17 6	
Lead:	£14 8 9 to £14 10 0	
Spelter	£14 16 3 to £15 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
f.o.b. Grangemouth—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	15/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/– to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6
Unscreened Navigation	12/9 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/– to 13/6
Secondary Steam	12/– to 12/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 16/–
Northumberland, Newcastle—	
Blyth Best	14/–
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/6
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	24/– to 26/– —
South Yorkshire Best	21/– to 23/– —
South Yorkshire Seconds	17/6 to 19/– —
Rough Slacks	8/– to 9/– —
Nutty Slacks	7/– to 8/6 —

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The French View of Ottawa.

As the value of Anglo-French trade declined by three-fifths between the years 1930 and 1934, when the Ottawa Agreement was put into operation, the French are disposed to regard this new development of British Imperial policy as partly responsible for the dwindling exchanges with foreign countries. With a view to showing exactly what had arisen out of the Ottawa Agreement, and explaining its reaction on trade between France and Great Britain, Monsieur du Halgouet, the French Commercial Attaché in London, delivered an address on the subject last week before the Comité National des Conseillers du Commerce Extérieur. Monsieur du Halgouet is not of the opinion that the Ottawa Agreement has materially affected trade between the two countries, because the heavy contraction of exports from France to Great Britain is equally observable in goods and produce that do not come within the classes of products favoured by Imperial preference. The slump in French exports is, he says, the consequence of high production costs. Nevertheless, Monsieur du Halgouet criticises the Ottawa Agreement on the ground that it ties the hands of the British Government in its negotiations with foreign countries, and claims that it represents theoretically an infringement of the "most-favoured-nation" clause, in the sense that the Dominions are independent States. The conclusion he comes to is that Great Britain will find it impossible to carry through successfully a closed economic policy, and that, in any event, errors will have to be corrected during the two years the Ottawa Agreement remains in force. Monsieur de Fleuriau, the former French Ambassador in London, who presided, explained how Great Britain had been forced into a policy of Imperial trade expansion and protection, and he did not believe that the country would return to Free Trade, because it was difficult to get away from Protection once it was adopted. The next two years will, he said, see changes indicating the trend of future British commercial policy.

Foreign Trade.

One result of the French official visit to Moscow is reported to be a Soviet promise to place orders with French manufacturers for the supply of railway and other material. This prospect of work has given satisfaction to engineering firms, which have long complained of getting nothing of the Russian business which was being distributed in other countries. The existing commercial arrangement with the Soviet Government has failed to benefit French engineering industries. Manufacturers attach far more importance to foreign trade now that home requirements are providing so little employment, and while the reduced unfavourable balance of trade, as revealed by the monthly returns, receives complacent comment, the continued diminution of exports is regarded with serious concern by all branches of industry. During the first four months of the year the imports declined by 1584 million francs, as compared with the similar period of 1934, and the exports fell by 596 million francs, notwithstanding an increase of 543,510 tons. This larger tonnage was the result mainly of consignments abroad of bounty-fed wheat, which doubled the exports of produce, while the value increased by only about 4 per cent. Exports of manufactured goods declined by 45,737 tons and the value by nearly 327 million francs. The failure to achieve much with short-time commercial agreements implies that no recovery can be anticipated until it is possible to carry out a comprehensive scheme of international exchanges.

The Seamen's Strike.

The recent strike of seamen at Havre is a repetition of similar strikes that have occurred from time to time on the eve of scheduled departures of liners, but in this case the dispute was much more serious, and involved a question of principle which the Government could not possibly entertain. When the Compagnie Générale Transatlantique was reconstructed, a board of control was instituted, comprising a majority of State delegates, and all other interests were represented upon it, including officers and men who had no voting power. This representation of seamen in what is now virtually a State enterprise apparently strengthened their determination to secure recognition of claims in the statute which the Minister of the Merchant Marine had prepared for them. The claim in dispute was that four-fifths of the seamen in the "Transat" fleet should receive regular pay as employees instead of being paid off at the end of each voyage. Though the statute has not yet been presented, the Seamen's Union learned that it did not cover this claim. With the idea of forcing the hands of the Government, the Union declared a strike which delayed the departure of the "Champlain" for New York, and threatened to make it necessary to cancel the arrangements for the festivities to be held on board the "Normandie." The Minister of the Merchant Marine, Monsieur Bertrand, refused to discuss the matter with the men until they returned on board. The men, on the other hand, were not disposed to accept arbitration, but on Sunday, May 19th, they decided to resume work. They have now modified their demand to the extent that they are prepared to accept a 50 per cent. proportion of permanent employment. The Minister's award is awaited.

Marseilles Water Supply.

Marseilles is supplied with water from the river Durance, and its filtration offers a difficult problem on account of its occasionally muddy character. The supply was also inadequate for the town and suburbs. A new installation has just been completed at Sainte-Marthe for dealing with 3,800,000 gallons a day, although the normal supply will be 3,000,000 gallons. The water is decanted in basins with compartment walls forming baffles, so that it takes 2½ hours to pass through, during which time the impurities in solution are coagulated by aluminium sulphate, and after filtering the water is sterilised by the ozone process. The installation covers 7176 square yards. This modern and efficient equipment relieves Marseilles of what has always been a serious cause of anxiety.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

426,679. February 8th, 1934.—THE REGULATION OR CONTROL OF INTERNAL COMBUSTION ENGINES, R. Bosch Aktiengesellschaft, 4, Militärstrasse, Stuttgart, Germany.

Many motor vehicles are now equipped with a starting carburettor which serves to facilitate the starting of the engine and to make starting possible with the engine still insufficiently heated. The starting carburettor is generally operated for such a length of time until the engine has become warm, and can therefore be operated with a poorer mixture. According to the invention an internal combustion engine has means for starting purposes, such as an auxiliary starting carburettor or an air-inlet choke-valve adapted to be closed on starting, and means for adjusting the ignition timing and is characterised in that a common control is provided for positively advancing the ignition timing, and for adjusting the engine starter. By this means starting is still further facilitated. The advantage of the invention comes particularly in question when the engine is very cold, because in this case the length of

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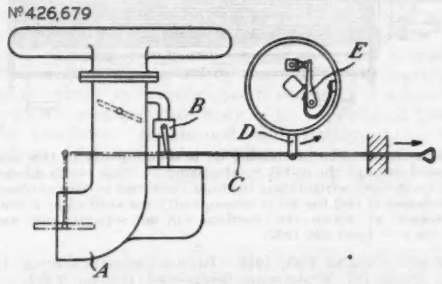

time for the ignition of the mixture is substantially longer than when the engine is warm. In the figure, A is the suction pipe of an engine, B a starting carburettor, and C a rod for controlling the starting carburettor. The adjusting lever D of an ignition interrupter E, which is arranged in a rocking casing, is connected to the rod C. The interrupter may be provided with a centrifugal governor which controls the ignition adjustment during the running of the engine. A starting motor (not shown) is provided for starting the engine. To start the engine, the driver pulls the rod C of the starting carburettor and thereby opens the valve of the starting carburettor. By this means he simultaneously adjusts the ignition to the advanced position. The angle by which the ignition is advanced preferably amounts to about 15 deg. The driver now operates the starting motor. By this joint action of the starting carburettor and the advanced ignition, the engine should, after a few revolutions, continue to run even when very cold.—*April 8th*, 1935.

426,681. March 22nd, 1934.—CYLINDER LINERS, The M.G. Car Company, Ltd., and C. Kimber, Pavlova Works, Abingdon-on-Thames.

This invention relates to the cylinders of internal combustion engines, of the kind wherein the actual barrel portion is of some hard-wearing material, such as a ferrous material, aluminium bronze, or the like, which is flanged at the top and held in a light alloy block, the cylinder head being of any suitable metal and being secured to the block, holding the barrel in place by means of the flange, which is gripped between the head and the block. The cylinder barrel or liner is of cast iron, and is formed hollow. At the lower end there is a cylindrical flange or spigot which projects into the crank chamber, and at the upper end the barrel portion is formed with a radial flange. In this flange apertures are made to communicate with the interior of the cylinder head water space. The barrel

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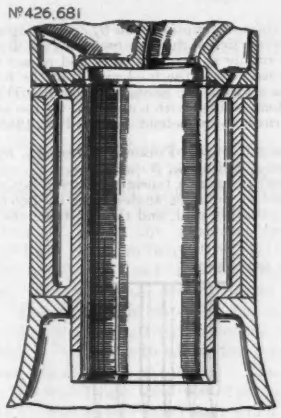

is a tight fit in a light alloy cylinder block, but it will be clear that no water pipe attachments are made to the cylinder block. The water is caused to flow along or across the cylinder head, and the barrel portions contain stagnant water in communication with the stream flowing through the cylinder head water space. It will be understood that the head and cylinder block are bolted together, or the head is bolted down to the crank chamber clamping the cylinder block flange between them. This causes the flange on the hollow barrel to be clamped between the head and the block, and to ensure an efficient gas seal there may be arranged an annular capsule type of sealing washer at the joint and close to the cylinder wall. A suitable known type of capsule for this purpose is one consisting of a hollow ring containing a gas under pressure, which deforms under the pressure of tightening up the cylinder head bolts, and increases its sealing qualities with high pressures in the cylinder.—*April 8th*, 1935.

TRANSFORMERS AND CONVERTERS.

426,666. November 30th, 1933.—METAL-CLAD VAPOUR ELECTRIC CONVERTERS, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and E. Gallizia, G.E.C. Works, Witton, Birmingham.

Mercury arc converters are, of course, rather uncertain in their action if their temperature falls below a critical point.

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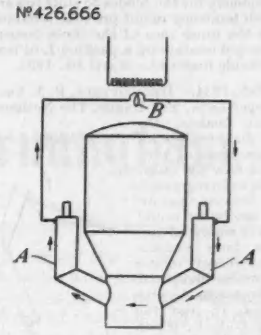

The inventors consequently connect the metal sheathing of the side arms A A with the secondary winding B of a transformer connected with any convenient source of electric power. The heating effect thus provided can be applied as and when required.—*April 8th*, 1935.

BATTERIES AND ACCUMULATORS.

426,654. October 11th, 1933.—ELECTRIC PRIMARY BATTERIES, C. J. Gordon, 77, Tufnell Park-road, London, N.7.

This battery is built up of a series of cupped receptacles A, made of an insulating material, which are nested together.

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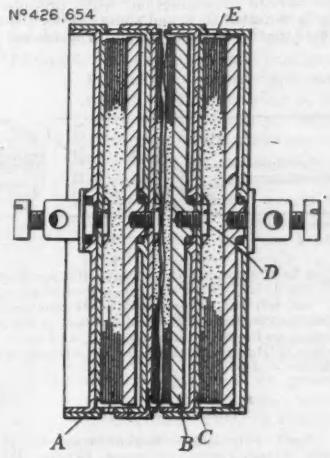

The electrodes B and C are connected together by screws D of a metal which will not corrode, and the electrolyte is held by absorbent pads E.—*April 8th*, 1935.

AERONAUTICS.

426,696. September 5th, 1934.—VARIABLE-PITCH SCREW PROPELLERS, Soc. An. Alfa Romeo, 33, Via M.U. Traiano, Milan, Italy.

In screw propellers of which the screw pitch is variable during flight, the propeller blades must be connected to the hub by means of devices capable of withstanding the centrifugal force, the aerodynamic thrust, and the bending moments; at the same time the absolute absence of play must be ensured as well as the reduction to a minimum of the effort requisite for turning the blades. Such devices, according to the present invention,

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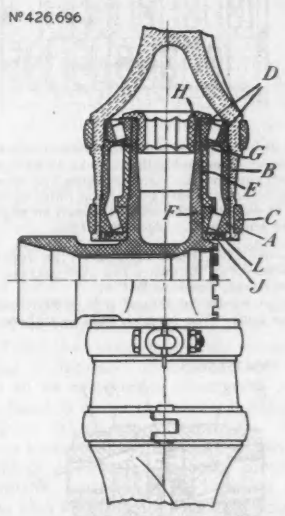
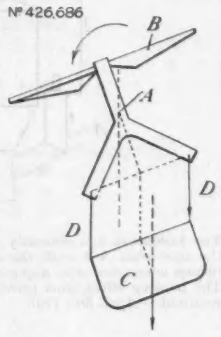


comprise two bearings, which are either taper-roller bearings, or ball bearings, having inclined race surfaces, arranged so that the inclinations of the race surfaces are in one and the same direction whereby the bearings are loaded simultaneously by the centrifugal force acting on the propeller blade. The outer race A of the inner bearing is extended and fitted with an externally screw-threaded portion on to which is screwed the blade B. Provided on the race A there are two cylindrical zones on which the blade B is centred and held in position by means of clamping rings C. In the upper inner portion of the race is formed a seat for the outer bearing D. The inner race

of the inner bearing is held in position by means of the sleeve E, which may serve as a distance piece for the outer bearing, the sleeve being screwed on the corresponding radial spigot or arm F of the hub. Between the sleeve and the inner race of the outer bearing D, a washer G is interposed, the thickness of which is so adjusted during assembly as to ensure that both bearings shall be subjected to the centrifugal force applied to the blade. The inner race of the outer bearing is held on the hub by means of the screw plug H. In order to avoid, when the propeller is at rest or is revolving with extremely low angular velocity, any tendency for the blades to shift towards the centre of the hub, which tendency might provoke a hammering on the bearings, under the inner race of the inner bearing a grooved washer J is arranged containing a packing L of leather, rubber, felt, or other suitable material.—*April 8th*, 1935.

462,686. May 7th, 1934.—HELICOPTERS, P. J. Van Poelvoorde, 24, Rietzanger Lane, The Hague, The Netherlands.

The inventor makes the remark that "due to loss of stability air navigation with helicopters until now has failed entirely, which is to be regretted, as a stable heavier-than-air aircraft which can hover would undoubtedly have many advantages over the huge gas-airships." He consequently makes his machine of two distinct parts, the ascension apparatus A, with its lifting screw B, and the weight-carrying body C, which are connected together by cords or links B D. It is suggested that if the machine should become out of balance and tend to tilt as shown by the curved arrow, the suspended weight will have an augmented restoring action.—*April 8th*, 1935.



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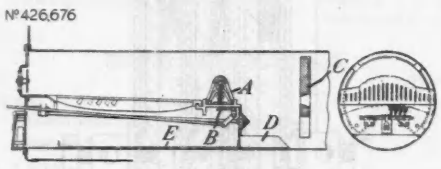
FURNACES.

426,676. January 20th, 1934.—SMOKE-ELIMINATING MEANS FOR BOILER FURNACES, G. R. Rosevere, 93, Kingston-road, Wimbledon, London, S.W.19.

The inventor describes a rather complicated form of fire bridge for service in connection with fire-tube boilers. This bridge is indicated at A, and admits air for the secondary combustion of the fuel from the ash pit. The amount of this air



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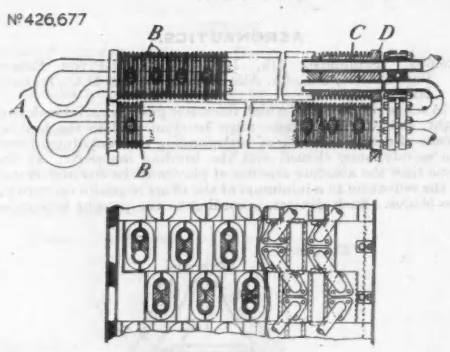
is controlled by the damper B. Beyond the fire-grate there is a baffle C, which is claimed to form a secondary combustion chamber. An ash pan is provided at D and can be withdrawn by the handle and rod E. The fire bars of the grate have diagonal openings for the admission of air, and have a convex upper surface, so that the fuel tends to spread out towards the sides of the fire.—*April 8th*, 1935.

MISCELLANEOUS.

426,677. April 8th, 1935.—ECONOMISERS, C. H. Sparks, Babcock House, Farringdon-street, London, E.C.4.

The economiser is formed of tubular elements A A, which are clamped by gilled cast iron blocks B B. A heat-conducting bond between the blocks and tubes is provided by a paste of



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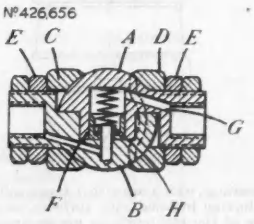
carborundum, any surplus of which is squeezed out through convenient openings. The end gilled blocks C have rectangular bosses D, which support the stack of units, one above another. If it is desired to remove any one of the units its end block is pulled back. It can then be turned through an angle of 90 deg and withdrawn lengthwise.—*April 8th*, 1935.

426,656. October 12th, 1933.—HINGED PIPE JOINTS FOR USE IN HIGH-PRESSURE LUBRICATING APPARATUS, E. Zimmt, 77, Gower-street, London, W.C.1.

This invention relates to hinged pipe connections for high-pressure grease guns. The hinge is able to withstand, without



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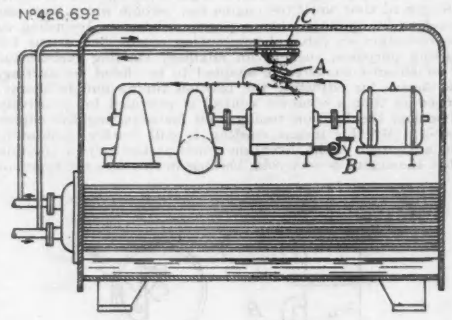
being influenced in its flexibility, a very high pressure up to 1000 atmospheres. The connection consists of two hemispheres, revolving round a spigot which are held together by one or more rings engaging their outside circumferences. The rings are fitted to the surface of the ball. If there is only one ring, it is positioned about the diameter of the ball and has a concave face on the inside. If there are two rings, then they are fixed at the two extremes of the ball towards the tube connections, and are of an internal diameter smaller than that of the ball. In the drawing A and B represent the two halves of the hinge which connect the respective ends of the pipes. Their heads are hemispherical, so that if put together they form a ball. They are held together by two rings C and D, which are pressed against the ball by nuts E. The hemisphere A has a spigot F, which fits into a corresponding cavity of hemisphere B. Round this spigot F the joint can turn to each side until rings C and D meet, which gives an angular freedom of 180 deg. In order to widen the range as much as possible the rings may be bevelled. The device works as follows:—The grease enters the joint by a bore G, presses an internal cup washer H against the inner wall of the spigot F and against the bottom of the cavity of the hemisphere B, and thereby absolutely seals the joint from the outside.—*April 8th*, 1935.

426,692. July 27th, 1934.—REFRIGERATING MACHINES, Aktiengesellschaft Brown, Boveri et Cie., Baden, Switzerland.

In totally enclosed refrigerating machines, the working parts of which are enveloped by the refrigerating medium, there is liable to be trouble through the lubricating oil for the bearings being diluted, or even washed away by liquid condensed from



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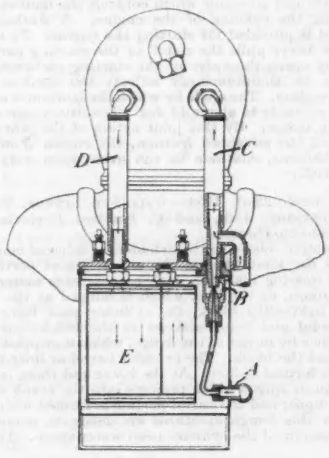
the medium. The lubricating oil is consequently in this case passed through the coil A by the pump B. This coil is flooded by condensed refrigerating medium produced by the auxiliary condenser C and the oil is consequently maintained at a temperature at which the medium will not separate out and dilute it.—*April 8th*, 1935.

426,962. October 12th, 1933.—DIVING APPARATUS, Sir R. H. Davis, 187, Westminster Bridge-road, London, S.E.1.

When a clothed diver descends into the sea the effect of carbon dioxide on his circulatory system increases as the depth increases to such an extent that the amount of air required for respiration becomes a serious consideration at great depths. The inventor



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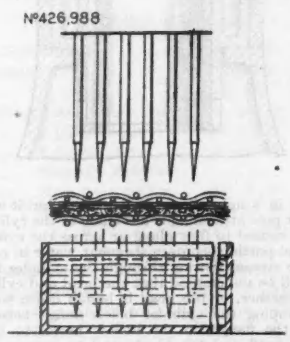
economises in this consumption of air by circulating and revivifying locally a proportion of the air supplied to the diver's helmet. The main air supply is provided at A and passes through the injector B on its way to the inlet pipe C of the helmet. This injector draws air from the helmet by the pipe D through the canister E, which is filled with a chemical for the absorption of CO_2, and returns it to the helmet.—*April 12th*, 1935.

426,988. June 5th, 1934.—FIBROUS MATERIALS, *R. F. McKay, Fort Dunlop, Erdington, Birmingham.*

It is proposed to make a fabric by placing layers of parallel fibres, arranged at different angles layer by layer, on a grid, superimposing another grid, and then piercing the mat with a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bunch of needles. The needles, after passing through the mat, are immersed in a bath of rubber latex and, on being withdrawn, pull back a certain amount of latex, which cements the fibres together. The illustration indicates two movements of the needles.—*April 19th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Mr. S. C. Roberts. 9 p.m.

TO-DAY TO FRIDAY, MAY 31ST.

BRITISH INDUSTRIES FAIR: ENGINEERING AND HARDWARE SECTIONS.—Castle Bromwich, Birmingham. Daily except Sunday.

SATURDAY, MAY 25TH.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Messrs. Cable and Wireless, Ltd., have invited the members to visit (i) The Central Station, Electra House, Moorgate, E.C.2; (ii) the Wireless Station at Ongar, luncheon at Theobalds Park Hotel, Waltham Cross; (iii) Wireless Station at Brentwood. 9.30 a.m.

PHYSICAL SOC.—Visit to Royal Holloway College, Englefield Green. Leave Charing Cross Underground Station, 1.30 p.m.

TUESDAY, MAY 28TH, TO FRIDAY, MAY 31ST.

INST. OF MECHANICAL ENGINEERS.—Summer meeting at Bath.

THURSDAY, MAY 30TH.

ROYAL AERONAUTICAL SOC.—In the Science Museum, South Kensington, S.W.7. Wilbur Wright Memorial Lecture and Conversazione. The Memorial Lecture will be read by Mr. D. W. Douglas. 9 p.m. to 12 midnight.

THURSDAY, MAY 30TH, TO SATURDAY, JUNE 1ST.

INST. OF AUTOMOBILE ENGINEERS.—Joint Summer Meeting with the Société des Ingenieurs de l'Automobile. Visit to Midlands and Oxford. For programme, see page 372, April 5th, 1935.

FRIDAY, MAY 31ST.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "How the Railways Fight the Snow." Mr. H. A. Vallance. 7.30 p.m.

TUESDAY, JUNE 4TH, TO FRIDAY, JUNE 7TH.

INST. OF GAS ENGINEERS.—At Inst. of Civil Engineers, Great George-street, S.W.1. Seventy-second Annual General Meeting. Presidential Address by Mr. C. V. Bennett. Paper, "National Policies Governing the Testing of Gas Appliances," Mr. Stephen Lacey and Mr. C. A. Masterman, 10 a.m.; President's luncheon at Savoy Hotel, 12.45 p.m. Afternoon session: Papers, "Problems and Answers in the Reconstruction of Manufacturing and Distributive Plant, Nottingham," Mr. G. Dixon, and "The Gas Account," Mr. W. B. McLusky, 3 p.m.; Park-lane Hotel, W.1, reception and dance. 9 p.m. Wednesday: "Development of Gas Sales: Policy and Performance," Mr. S. B. Chandler; 10 a.m., general meeting of Benevolent Fund; 11 a.m., lecture, "The Tactical Use of Carburetted Water Gas as a Coal Gas Auxiliary," Dr. A. G. Glasgow, 11.15 a.m.; visit to Rochester Gasworks, 12.50 p.m. Thursday: Papers, "Waste Heat Recovery from Retort Settings," Major W. Gregson, "The Preparation, Marketing, and Utilisation of Coke," Mr. W. L. Boon, 10 a.m.; afternoon: Visits. Friday: Tour in Kent, leave Victoria, 9.20 a.m.

SATURDAY, JUNE 22ND.

INST. OF AUTOMOBILE ENGINEERS: GRADUATES' SECTION.—Summer Rally at Burford, Oxon. The President, Mr. L. H. Pomeroy, and Mrs. Pomeroy will hold a reception at the Cotswold Gateway Hotel, Burford, at 3.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. CHARLES F. RUSSELL, sales manager, has been appointed the new general manager of Specialloid, Ltd., London.

BIRMINGHAM ELECTRIC FURNACES, Ltd., has acquired the sole rights in the British Isles for the Lindberg regulator. This instrument has been supplied previously only by the Lindberg Steel Treating Company, of Chicago, U.S.A. but will now be manufactured and sold in England under the name "Birlec-Lindberg" controller.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

BASTIAN AND ALLEN, Ltd., London, are to provide an electrical boiler of 200 kW capacity and the necessary electrical and controlling switchgear for heating the new Electricity Offices at Nottingham on the electrical thermal storage system. The order for the heating installation has been placed with Thos. Danks and Co., Thurland-street, Nottingham.

MERRYWEATHER AND SONS, Ltd., of Greenwich, have received from the City Council of Leicester an order for a motor turntable fire escape with all-steel ladder to reach a height of 100ft. The ladder will be equipped with life-saving apparatus, a monitor nozzle, and telephone apparatus. The machine will also be fitted with a fire pump capable of delivering 400 gallons per minute, and with a searchlight, which can be used on or away from the machine.

SIMON-CARVES, Ltd., of Stockport, have received from Dorman, Long and Co., Ltd., what is believed to be the largest order for coke ovens ever given in this country. The contract comprises 136 ovens, together with complete by-product plant, coal and coke-handling and coke-screening plant. The ovens and plant are to be built at the Cleveland Ironworks, and will be of the "Underjet" twin-flue compound type, arranged for firing either by coke oven gas, blast-furnace gas, or both. The ovens will have a total capacity of more than 3000 tons of raw coal per day. The machinery includes electrically operated rams, coke-charging cars, coke guides, coke cars, and locomotives. The screening and handling plant will deliver the coke to the blast-furnace bins by conveyors, and provision is also made for loading furnace coke to wagons for delivery to other of the company's works, if required. Screening plant will be provided for the separation of furnace and domestic coke. The by-product plant is designed for the recovery of ammonia as sulphate, and for the recovery of benzole and tar. The contract also includes electro-static detarring equipment. The coal-handling plant will comprise complete coal unloading, blending and crushing systems. A 4500-ton coal storage bunker and a coke-quenching tower are also included. A large proportion of the steelwork required for the new plant will be supplied by Messrs. Dorman, Long themselves. About 20,000 tons of specially made refractory bricks will be required for the coke ovens.